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ELECTRIC POWER SCHEMES IN ENGLAND.

An interesting phase of the electrical awakening which seems to be going on in England is the construction of large electric power plants intended to deliver current for light and power purposes throughout large districts. One of the most important of these, and one which is typical of the general plan, is that of the Yorkshire Electric Power Company.

This company is preparing to erect power stations and deliver current through a section of country having an area of about 1,800 square miles. The district contains eighteen boroughs and 118 towns, besides a number of rural sections. The power consumers are textile mills, mines and manufacturing establishments of various kinds, and it is estimated that they are now using about 3,000,000 steam horse-power. The Yorkshire company has authority to build five generating stations and to dispose of power throughout the entire district, except where it comes in conflict with certain municipal plants now existing. At the present time one of the main power-houses has been put into service, and a number of substations have been erected. The system will be extended as rapidly as the demand for power warrants.

This Yorkshire undertaking is in striking contrast to the conditions prevailing in a number of British cities, notably London, where there is a large number of small plants operating independently and most probably inefficiently. The Yorkshire factories, on the other hand, will draw power from a large, and therefore reliable, plant which will generate its power on a scale which will make it cheap. The factories will have an opportunity—which, no doubt, large numbers of them will grasp—of discarding the old, clumsy and inefficient steam drive for the new electric drive, and thereby will not only get better work out of their shops, but will be able to do more of it. Probably there are not many sections in this country offering such a favorable opportunity for power schemes of this character. It must be remembered that the Yorkshire company is not developing a water-power, but is simply creating a large modern electric power system in a district where it must depend upon coal. Nevertheless, there are a number of places in this country where small manufacturing towns lie sufficiently close together to make a scheme of this kind worth considering.

THE FIRE-ALARM TELEGRAPH SYSTEM OF THE CITY OF NEW YORK.

The report of the committee on fire-alarm service in the borough of Manhattan to the New York Board of Fire Underwriters has been made public. While it was anticipated that the result of the investigation would show a more or less decadent condition of service, it was not expected that it would show such out and out rottenness as has been discovered. It may be said, however, to the credit of the New York fire department and the administration headed by Mayor George B. McClellan, that the investigating committee has been afforded every facility, and the municipal officers have entered with hearty accord into the proposition to get the fire-alarm telegraph system on a sound, practicable working basis.

The investigation has been very thorough. The findings disclosed and the recommendations made are from a recognized expert, and have the corroboration of other expert minds who understand the technical intricacies of this form of service. The cost approximated is not excessive, and, compared with the hazard which is at stake, is small indeed. As the present administration has aided very materially in making this investigation and report possible, and the matter is entirely without the domain of politics, it is to be hoped that nothing will be placed in the way of speedily securing for this great city the adequate facilities which are urgently necessary, and which it certainly can afford.

ELECTRICAL POWER IN INDIA.

One of the important industrial developments of India during recent years has been the utilization of the water power of the Cauvery river at Sivasamudram. At this point there is a fall in the river of nearly 400 feet. The amount of water flowing makes available during the dry season about 12,000 horsepower. The electric power generated here is transmitted ninety-two miles to the Kolar gold fields, where the greater part of it is utilized in mining operations. Other districts are also supplied, though to a less extent. The first installation, which was completed in June, 1902, had an available output of something over 4,000 kilowatts, but the demands for power from the gold fields increased so rapidly that an addition has been necessary. This was completed in December, 1904, the increase in output being about 3,600 kilowatts.

This important hydroelectrical development, which is now the largest in southern Asia, is described in an interesting article by Mr. A. C. Hobble, the first section of which appears in this issue of the ELECTRICAL REVIEW. Mr. Hobble is one of the engineers who has been associated with this work for some years past, and is thoroughly familiar with all the conditions in that section. His description is the more valuable, in that it does not waste time on details of generator and turbine construction with which all are familiar, but discusses fully the engineering features. The experiences in connection with the original installation have led to certain changes in the new. These are pointed out in the description, the reasons in each case being indicated.

The conditions met by the engineers of this plant were, in general, not so different from those found elsewhere. Certain new features had to be contended with, however. The use of wood for poles and conduits was prohibited because of the danger from white ants. Electrical storms are not infrequent, and are often very severe. The country crossed by the transmission line is frequently rough and difficult, and at such places the transmission lines are exposed to the full fury of the storms. One interesting result of experience with these transmission lines was that they are less liable to damage from lightning at elevated points than in the valleys. The presence of moisture in the air seems to increase considerably the liability of lightning troubles. These troubles have, however, been overcome largely by the use of choking or kicking coils in the line circuit. In the earlier lines these coils were omitted, the result being that several transformers were damaged. Since the addition of choking coils as an auxiliary to the lightning arresters, no further damage has occurred. The experience of this plant points to the advisability of insulating the electrical apparatus from the earth. This was the practice followed generally in this country until the direct-connected generator was adopted as the standard for all large units. The opposite practice prevailed largely in Europe, where it was contended that while an insulated frame was more protection to the apparatus, it was more dangerous to the attendant.

To the Cauvery plant belongs the honor of being the first important hydroelectrical development in India. Its success has opened the way for further development in this field, one of the most important being that in Kashmir on the Jhelam river, where the installation of a 15,000-horse-power plant and the building of a 200-mile single-phase electric railway are contemplated. These plants may lead to important industrial developments in India in other directions. Mr. Hobble points out that there are in southern India rich mineral deposits, particularly of iron and aluminum. As fuel is scarce and transportation at the present time difficult, these deposits have remained undeveloped; but the supply of a large amount of cheap power there may make it profitable to develop them.

Changes in other directions are also taking place, for, besides the work at the mines, electric light systems and electric railways are being put into service or projected in the cities within reach of the power system. It is probable that the awakening taking place in this district of southern India may influence other sections and bring about a general stimulation of business. Indeed, the influence seems already to have been felt, for a number of important electrical installations have already been made at other points.

A SOUND PLEA.

The excellent paper read by Dr. Wilder D. Bancroft at the recent meeting of the American Electrochemical Society, and which was published in full in the issue of the ELECTRICAL REVIEW for October 7, makes a sound plea for the logical study of electrolytic methods. Much of our knowledge of electrolytic processes has been obtained through methods and arguments not distinctly chemical; hence the reactions which are brought about have often been viewed as peculiar. Electrical energy has been thought of as acting in a way distinctively its own, and electrochemistry has been looked upon as a distinct branch of chemistry. Dr. Bancroft takes the stand that this is undesirable; that the reactions taking place during electrolysis are essentially chemical reactions, and that by making the conditions suitable these same reactions may be brought about by purely chemical means. This argument was strengthened by many experiments conducted during the presentation of his paper.

This stand seems certainly to be a reasonable one. There is no need of attributing to electrical energy any special virtues, and if electrolytic reactions can be explained by purely chemical reasoning, the science will thereby be materially simplified. In fact, this is really only a step in the logical direction, for as our knowledge of the different branches of science broadens, we find that these branches become more and more intimately connected, and that the many separate laws become correlated and are finally reduced to a few broad principles.

Dr. Bancroft, however, pointed out that there are many electrolytic reactions which have not been explained chemically. He at the same time took occasion to point out many fields open for interesting and valuable research which have as yet been neglected. So much energy and investigative skill have been expended, with such excellent results, in extending our knowledge of chemistry, that it is to be hoped a similar activity will be exerted in the study of electrochemical reactions, for there is no doubt that much information of the greatest value would thus be obtained.

POWER TRANSMISSION BY DIRECT CURRENTS.

The lecture delivered by Professor W. E. Ayrton before the British Association for the Advancement of Science, at Johannesburg, South Africa, brought up a number of points of much interest.

The part of most concern to electrical engineers is undoubtedly that in which Professor Ayrton comes out as an advocate of direct-current transmission. After indicating how the electrical industry has been hampered by unwise restrictions —one of which limits the voltage that may be used to 10,000— Professor Ayrton went on to show how much superior a direct-current system should be to the alternating. In the latter the generators are operated in parallel and deliver their output through an expensive and complicated switchboard to a series of step-up transformers which raise the voltage to that used in transmission. At the receiving points similar apparatus is required, arranged in the reverse order. There must be step-down transformers and switchboards, and the motors—and generally the lights—are operated in parallel.

Contrasted with this, the direct-current series system seems simple. The switchboard is practically eliminated, and this is a considerable gain, since one of the features of the parallel system has been the extension and development of the switchboard until it has practically become a third department of the power-house.

The next point made against the alternating-current system is the effect of capacity and inductance in the line. Each of these alone lowers the power-factor of the line, thereby increasing the losses and affecting the regulation. While the two, if properly balanced, may neutralize each other, such a condition may give rise to resonance, with disastrous results. In a direct-current system the power-factor is unity, so that these troubles are eliminated. Moreover, there should be no serious leakage due to brush discharges if, as would generally be the case with the direct-current system, the line go out in one direction and return in another. Another advantage urged by the lecturer was the superiority of a series system as regards regulation, it, in his opinion, being easier to maintain a constant flow of current in the line than to maintain a constant voltage at the far end. Considered from a central station viewpoint, this contention might be admitted; but what one wishes is not perfect line regulation, but perfect operation of the receiving apparatus. It is easier to maintain a constant speed, given an approximately constant voltage, than if supplied with a constant current and variable voltage; and, further, on alternating-current systems, the speed of the motor varies but little with the voltage. As regards lights, both systems will, in general, require motor-generators, so that the conditions most suitable for speed control of motors will be those best adapted for the regulation of lights.

That phase of the direct-current system which appeals to most engineers is the decreased strain on the insulation, as compared with the alternating system. This strain varies with the maximum voltage, while the power transmitted depends only on the effective voltage; therefore, with a pure sine wave, 60,000 volts alternating causes nearly as much strain on the insulators as 85,000 volts direct; and, further, since the electromotive-force wave may be peaked, due to the characteristics of the system, it is possible for the strain on the insulators of a 60,000-volt system to run up to 100,000 volts or more, and if resonance occur, there is no saying how high it may go. It is this feature of the direct-current system, more than any other, which may lead to its consideration. It is true that the system has been in successful operation—so far as can be determined—in Europe, but the voltage there used is considerably lower than that employed on alternating-current systems at many points in this country, and hence this argument as yet has not much force. The main argument made there is the simplicity of the system. Now, as already noted, this may be admitted as regards the switchboard and arrangement of apparatus. But it is questionable whether it is any easier to operate commutator machines in series than alternators in parallel, and the series system certainly seems much inferior to the parallel system as regards flexibility. It can not branch off and take in small consumers. Large users of power can attach their motors directly to the transmission line, but small consumers must be supplied from substations anyhow. The direct-current system therefore seems to be more suitable for transmission of power in large blocks from one point to another or to several points in series than for a general distribution system. One of the main advantages of an electrical supply system is its flexibility, and any system lacking in this respect must prove its superiority over the accepted systems in other ways before it can hope for a wide application.

ALTERNATING-CURRENT ELECTROLYSIS.

At a recent meeting of the Faraday Society (the electrochemical society of Great Britain) a paper was read by Mr. Ernest Wilson on "Alternating-Current Electrolysis," which was evidently the result of a preliminary study, since all conditions were not held strictly constant, so that broad conclusions can not be drawn.

The paper shows, however, what was already known, that electrolytic action does take place, due to the passage of an alternating current. The amount of metal dissolved seems to depend rather on the current density at the electrodes and on the frequency, than on the total coulombs passing during each half cycle. With a frequency of twenty-one and one-half cycles, the effect is greater than at ninety-two cycles, the difference, however, varying with the metal of the electrodes and other conditions. In one experiment with lead electrodes, with an effective current density of 0.023 ampere per square centimetre, the depth to which lead would be cut away from the plate in one year is computed to be 2.6 centimetres for a frequency of ninety-two and one-half, and 4.8 centimetres for a frequency of twenty-one and one-half. The same current density with direct current would eat away seventy centimetres in a year.

These experiments may have some bearing on the question of electrolysis of underground conductors. It is frequently assumed that the use of alternating currents for railway work will entirely eliminate all electrolytic corrosion; but such a deduction is unwarranted on the face of these results. The difference in effect, however, is very great, and the conclusion may safely be drawn that, for all practical purposes, the use of alternating currents will do away with electrolysis troubles.

THE ELECTRICAL NATURE OF MATTER AND RADIOACTIVITY.

BY HARRY C. JONES.

CHAPTER VI.

The Discovery of Radium.

It having now been shown that two elementary substances, uranium and thorium, are radioactive, a large number of substances were examined with respect to this property. Among these would naturally be the minerals in which uranium and thorium occur.

Mme. Curie determined the radioactivity of a large number of minerals, by measuring the conductivity of the air when exposed to these substances. She found that all minerals which show radioactivity contain either uranium or thorium. What was very remarkable, was the fact that *certain minerals which contain many things in addition to uranium, were much more radioactive than uranium itself.* Thus, pitchblende from Johanngeorgenstadt had four times the radioactivity of pure uranium. Pitchblende from Joachimsthal was three times as radioactive as uranium, while pitchblende from Pzibram was nearly three times as radioactive.

Chalcolite, which is a double phosphate of copper and uranium, is about two and one-fourth times as radioactive as metallic uranium, while Autunite, a double phosphate of calcium and uranium, is about one and one-fifth times as radioactive as uranium.

Only a part of every one of these minerals is uranium, and as Mme. Curie says, "these facts are directly at variance with the earlier observations, according to which no mineral could be more strongly active than uranium or thorium."

Mme. Curie then prepared chalcolite artificially by treating a solution of uranium nitrate with a solution of copper phosphate in phosphoric acid, and warming the mixture to fifty or sixty degrees. Under these conditions crystals of chalcolite formed, after a time, in the liquid.

The radioactivity of this artificially prepared chalcolite was two and one-half times *smaller* than that of uranium itself. This led Mme. Curie to conclude that the unexpectedly great activity of the natural minerals was due to the *presence in them of small quantities of some strongly radioactive substance,* which was not uranium, not thorium, nor any other known substance.

With this idea in mind M. and Mme. Curie undertook to separate from the uranium minerals the supposed new radioactive substance, and with signal success.

THE SEPARATION OF RADIUM FROM PITCHBLENDE.

Pitchblende, as is well known, contains in addition to uranium, a large number of other elements in small quantities. The separation of pitchblende into its constituents, or even the separation of any constituent in pure form, is not likely to be a simple matter. The Curies, however, worked out a chemical method for effecting the desired separation, and obtaining the highly radioactive substance or substances.

In the various chemical processes to which the material, as we shall see, was subjected, they followed the course of the radioactive constituents by determining the radioactivity of every product by means of the electroscope. They could thus determine what chemical operation was concentrating the radioactive substance.

There are at least two, and possibly three radioactive constituents in pitchblende, in addition to uranium itself. One of these, called *polonium* from the native country (Poland) of Mme. Curie, resembles in its chemical properties the element bismuth, and is separated from the pitchblende along with this element. The element radium, with which we are now chiefly concerned, is closely allied chemically to barium, and comes out of the pitchblende along with the barium.

A third radioactive substance, *actinium,* has been described by Debierne, as occurring in pitchblende. It seems to separate from pitchblende along with certain of the rare elements, and especially thorium.

To give some idea of the number and complexity of the chemical methods involved in separating radium from pitchblende, a brief review of Mme. Curie's account of her own work is appended. All of the new radioactive constituents occur in pitchblende in *minute quantities,* so that it is necessary to work over enormous quantities of material in order to obtain even a few milligrammes of the comparatively pure radioactive substances.

We shall confine our account to the separation of radium from pitchblende, which, we will remember, comes out along with the barium, to which it is so closely related chemically.

The finely powdered pitchblende is fused with sodium carbonate, and the product extracted first with hot water, and then with dilute sulphuric acid. The uranium is contained in the solution, and since the pitchblende was worked for the uranium that it contained, the residue, after the above treatment, was thrown away. It is this residue that contains the radioactive constituents. It has a radioactivity about 4.5 times that of metallic uranium.

This residue consists mainly of the sulphates of lead and calcium. It also contains aluminum, iron, silicon, and larger or smaller amounts of nearly all known metals. The radium exists in this mixture of sulphates. Its sulphate is the least soluble of all.

The problem now is to separate the radium from this mixture of sulphates. The residue is freed, as far as possible, from sulphuric acid, in order to get the radium in solution. To accomplish this, the residue is treated with a concentrated, boiling solution of sodium hydroxide. The sulphates of calcium, aluminum and lead are thus, for the most part decomposed, the sulphuric acid combining with the sodium as sodium sulphate, which is removed by washing with water. The sodium hydroxide also removes the aluminum, silicon and lead by dissolving them. The residue insoluble in the alkali is washed with water and then treated with hydrochloric acid. The portion that dissolves contains the actinium and polonium. The radium remains in the residue insoluble in hydrochloric acid.

The polonium can be separated from the hydrochloric acid solution by means of hydrogen sulphide; it being thrown down with a number of other substances by means of ammonia.

The insoluble portion containing the radium is washed with water, and then treated with a concentrated, boiling solution of sodium carbonate. By this means the barium sulphate is transformed into carbonate. The substance is now thoroughly washed with water, and treated with hydrochloric acid. The radium is contained in this solution. It is precipitated by means of sulphuric acid. The precipitate also contains barium and calcium, lead and iron. This is the radium-containing barium in the form of crude sulphate.

From a ton of the residue obtained from pitchblende, ten or twenty kilogrammes of the crude sulphate, having an activity from thirty to sixty times that of metallic uranium, which is taken as unity, can be obtained.

The crude sulphate is boiled with a solution of sodium carbonate, and then transformed into chloride by treating the carbonates with hydrochloric acid. Hydrogen sulphide is run into the solution,

when a small amount of active sulphide is thrown down, which contains polonium. The sulphide is filtered off, chlorine run in as an oxidizing agent, and then ammonia added. The strong activity of the precipitated oxides and hydroxides is due to actinium. Sodium carbonate is then added to the filtered solution, when the carbonates of the alkaline earths are thrown down. The carbonates are transformed into chlorides by added hydrochloric acid, and the chlorides, after evaporating the solution to dryness, are washed with pure concentrated hydrochloric acid. This dissolves the chloride of calcium, while the chlorides of barium and radium are insoluble in the acid.

About eight kilogrammes of this product, being mostly barium chloride, is obtained from a ton of the original residues. The radium chloride is mixed in small quantity with the barium chloride. This is shown by the fact that the activity of the radium-bearing barium chloride is about sixty times that of pure uranium.

The process of preparing pure radium chloride, instead of being ended, is really now only begun. The following process of obtaining radium chloride from the mixture with barium chloride, is described by Mme. Curie.

The principle of the method is *fractional crystallization,* using at first pure water, and afterwards water to which hydrochloric acid had been added. The chloride of radium is less soluble than the chloride of barium.

The first fractionation is effected in pure water. The chloride that separates from the saturated solution is much more active than the solution, as would be expected, since the chloride of radium is less soluble than the chloride of barium. By utilizing this fact, and fractionating the mixture in terms of it, after a long series of fractionations, discarding the weakly active portions, most of the inactive barium chloride is removed.

When a large number of fractionations have been made, and the amount of substance has become small, it is better to add hydrochloric acid to the water, since this diminished the solubility of the salts, and more rapid separations are effected.

Mme. Curie observed that the crystals of radium barium chloride remain colorless, until the amount of radium has reached a certain per cent of the whole mass. When the radium salt has reached a certain concentration, the crystals become yellow, then orange, and even at times show a beautiful rose color. This color disappears when the crystals are again dissolved. The appearance of this color is rather remarkable, since crystals of pure radium chloride are colorless. The color indicates that a certain degree of purity has been reached, and has a maximum intensity when the amount of barium present is a certain definite quantity. After this concentration is reached, the intensity of the color becomes less and less as the purity of the crystals becomes greater and greater. When the radium has become freed from all appreciable quantities of barium, the color practically disappears from the crystals. Thus, the color of the crystals can be used as an index to the progress of the separation of barium from the radium—of the degree of purity of the radium salt.

By the above described method radium chloride can be obtained, having a radioactivity that is *one million times that of the mineral from which it came.*

When we consider the number of steps in the above described process, and the details of every step, and then remember that every one of these details had to be worked out empirically by the Curies, we gain some idea of the enormous task that they have performed, and the difficulties at every step, which they must have encountered and have overcome.

After all this had been done, the amount of radium chloride obtained from a ton of the residues from pitchblende, was only a *few milligrammes.* This necessitates the working over of enormous quantities of the original pitchblende, in order to obtain any appreciable quantity of the radium salt. Fortunately, this problem is rendered much less difficult than it would otherwise be, by a cooperation on the part of the factories in which pitchblende is used. Many of the steps described in the above process can be taken *more successfully* on a large scale, than on a small one, to say nothing of the amount of time and labor that it would be necessary to expend in performing these operations in the laboratory. Indeed, if we were dependent upon the laboratory alone for our supply of radium, our knowledge of this substance would have accumulated infinitely more slowly than it has done.

Other methods have been proposed for purifying the radium salt, which are hardly more than modifications of certain details of the method worked out by the Curies and described above.

Gietel fractionated a mixture of barium bromide and radium bromide, with good results. The Curies found that the addition of alcohol to the aqueous solution of the mixed chlorides of radium and barium, facilitated the separation of these two substances from one another. The chloride of barium is more readily soluble in the mixture of alcohol and water, and is thus separated from the radium chloride. This process has been found especially useful in separating the last traces of the barium from the radium.

The question that arises is whether some source of radium richer than pitchblende may not yet be found. Radium has been shown to be very widely distributed over the surface of the earth. It occurs in a large number of minerals, in the waters of many springs, in the soil and rocks, and probably in many places not yet discovered. While sources of radium that are richer in this substance than the richest pitchblendes may yet be found, it appears to the writer to be doubtful whether any material very rich in radium will ever be found.

This opinion is not based so much upon the ease with which radium is detected by means of the spectroscope, or upon the comparatively wide search that has already been made for this substance, as it is upon the *instability of the substance itself.*

As we shall see, radium is not a stable substance. It is continually undergoing decomposition into other things. It would, therefore, be very surprising, if any large quantity of it should be found in any one locality.

(Chapter VI to be continued.)

The Properties of Tantalum and Its Alloys.

British patents have been granted recently to Siemens & Halske, for tantalum alloys. The engineering supplement of the London *Times* gives a summary of the properties of tantalum and its alloys, taken from these patents.

Tantalum is exceedingly strong, and has great elasticity. It is like steel, easily worked and hardened. The addition of small quantities of carbon gives it great hardness, though other elements, such as oxygen, silicon, and aluminum and tin, can take the place of the carbon. Small traces of these elements only are necessary if hardness is to be obtained. When larger quantities are added, the metal becomes brittle and can not be worked. Under certain conditions these alloys are almost as hard as the diamond. Tantalum can be case-hardened by heating to redness in carbon dust. It is unaffected by the atmosphere at ordinary temperatures, and resists most acids. The metal can be made comparatively soft so as to be worked easily by heating or melting, but, when worked, gains rapidly in hardness and needs frequent reannealing. It is rapidly oxidized at high temperatures, and the best method of fusing it is to heat it by an electric current in a vacuum. At the present time tantalum is very expensive, so that its use will be restricted; but should it be produced in considerable quantities, it will have great value for use in those parts of machines which are subject to strong mechanical action, such as balls, ball bearings, cones, cams, rollers, etc.

THE FIRE-ALARM TELEGRAPH SERVICE IN GREATER NEW YORK.

A SEARCHING INVESTIGATION AND REPORT BY THE COMMITTEE ON FIRE-ALARM SERVICE FOR THE BOROUGH OF MANHATTAN OF THE NEW YORK BOARD OF FIRE UNDERWRITERS.

On December 21, 1904, the New York Board of Fire Underwriters passed a resolution for the appointment of a committee of five to investigate and secure a report by experts on the fire-alarm telegraph system of Greater New York, reporting back to the board. Upon receiving the preliminary verbal report, the board, on February 15, 1905, passed the following resolution:

"*Resolved,* That the special committee to investigate by experts the fire-alarm telegraph system of Greater New York, acting under resolution adopted at the December meeting of the board, be authorized to expend not exceeding $10,000 in completing such investigations."

The committee appointed was as follows: C. F. Shallcross, chairman; John M. Whiton, W. B. Ogden, Charles H. Post and C. G. Smith.

The Hon. Nicholas J. Hayes, fire commissioner of the city of New York, was interviewed by the committee, and expressed himself as very willing to assist, as far as possible, in the furtherance of the investigation, and the committee has recorded its indebtedness to the commissioner, to Deputy-Commissioner Churchill, to Chief Croker and their subordinates for the courtesies shown and the facilities rendered in carrying on this important work.

After a careful enquiry, Mr. Kempster B. Miller, a specialist in electric signaling, was selected for the expert investigation.

Under date of September 9, Mr. Miller has presented a voluminous report containing the details of a searching investigation into the present condition of the fire-alarm telegraph system and the methods which should be followed in order to give the city an adequate fire protection.

Mr. J. J. Carty, as consulting engineer, has kept in close touch with the investigation, and has scrutinized the methods employed and considered the evidence as it was obtained from time to time. Mr. Carty concurs in the findings of Mr. Miller, and agrees that the plan will, in every reasonable manner, provide for the maximum degree of reliability of operation and minimum expense of maintenance, and that it will be in first cost—all things considered—the most economical one for the city of New York to adopt in place of the defective system now in use.

The full report comprises the following:

A report on the fire-alarm telegraph system of the borough of Manhattan.

An abridged report on the fire-alarm telegraph system of the borough of Manhattan.

Appendix A, containing notes on the condition of the fire-alarm telegraph cables in the manholes and service boxes of the Empire City Subway Company.

Appendix B, containing notes concerning photographs of terminal boxes of the New York fire department. The photographs of the terminal boxes are a part of appendix B.

Appendix C, notes on photographs showing the condition of fire-alarm cables in manholes. The photographs showing the condition of cables in manholes are a part of appendix C.

Appendix D, the electrical measurements on circuits and underground cables in the New York city fire-alarm telegraph system.

Appendix E, the record for the month of March, 1905, of the troubles in the fire-alarm telegraph system on the island of Manhattan, according to the journal kept at fire headquarters.

Appendix F, notes on the condition of the fire-alarm cable suspended on the structure of the Third Avenue Elevated Railway.

There is also a series of maps showing the present location of the cableways and terminal boxes of the system, and the proposed cable system and location of central office and apparatus houses.

As it will be manifestly impossible to publish in the space available the full report, the following abstract is given, in which an attempt is made to cover the essential points.

The design, construction and operation of the central office at fire headquarters were thoroughly gone into. The suitability of the building itself and its location were subjects of careful study. The location of the fire-alarm boxes and also of the engine and other apparatus houses—in fact, of all points reached by the system—were determined and plotted on maps. The fire-alarm boxes were examined and their condition and construction studied, and an inspection was made to ascertain the fitness of the signal apparatus at the various company quarters.

A long series of electrical tests was made upon the cables, and their mechanical condition examined in an exhaustive manner. Electrical measurements were made upon all circuits entering fire headquarters. The report continues:

"As a result of this investigation, which was carried out with the utmost care, into every essential detail, it has been found that the fire-alarm telegraph system of the borough of Manhattan is fundamentally wrong in design and is in bad physical condition. It is not constructed in accordance with any proper engineering plans, and its physical condition is so bad that it must be characterized as being in an advanced stage of decay. It is liable at any time to such failures as to render it wholly useless to the fire-fighting department in the time of greatest need.

"Faulty in original design and construction, the plant has deteriorated and has been patched and repaired in its various parts as they, from time to time, became unworkable. The system long ago reached the stage where it can not be transformed into permanent proper working order by any further patching, or even by radical repairs."

The report states that the present fire-alarm headquarters on East Sixty-seventh street fails in every essential particular to comply with the proper requirements for a central office building. Even if the building itself were isolated, it is not otherwise suitable. It is occupied by the various bureaus of the fire department, and although classed as a fireproof building, it is of an old type and contains within itself hazards of explosion and fire. Instead of providing a non-combustible mounting for the fire-alarm apparatus, such as slate, marble and steel, the apparatus is mounted on wooden supports and encased in extensive wooden cabinet work. The underground approaches to this building constitute a continuous and serious danger of total interruption. All the circuits entering the office pass through a single approach to the building and thence through a single shaft to the operating room. An accident by fire or otherwise to this approach or to this shaft might disable all of the circuits of the entire system. On Sixty-eighth street there is a manhole through which all the circuits entering headquarters pass. An accident to this manhole by explosion, flood, fire, cave-in or otherwise might also destroy all connections between fire headquarters and the rest of the city.

The report reviews the type of cable which should be used in the distributing

and feeder circuits. The wires in the cables should be insulated with the best type of rubber insulation known to the art. These rubber-covered wires should, in turn, be enclosed in a lead pipe forming a sheath. By the use of rubber-covered wire in this manner, accidental cracks and small openings in the lead sheath do not produce immediate deterioration of the cable. Such small defects in the sheath would simply operate to produce at the point of opening an incipient fault, which would take years to develop, and which would be discovered by the operators in charge long before they could produce an interruption.

Commenting on the present condition of the cables, the report continues:

"With the type of cable, however, which comprises the bulk of the fire-alarm cable system of the borough of Manhattan, the insulation of the wires is not of the waterproof type, but consists of a wrapping of fibrous material soaked in a compound which fails to keep out moisture. Seventy-seven per cent of the cable system of the fire-alarm system of Manhattan is composed of this type of cable. When cracks and small openings occur in the sheaths of such cables, moisture is allowed to enter. This creates faults which extend as far as the moisture penetrates, and in the course of time, by permitting the current to escape from the wires, causes a gradual deterioration of the working of the circuits and, ultimately, failure. As will be shown hereafter, the lead pipes covering these fibrous fire-alarm cables abound in cracks and openings which have allowed moisture to enter and caused decay. As a consequence of this, the cables of this type are in a hopelessly defective condition. They are bad beyond repair."

The general arrangement of the circuits is stated to be unsystematic, and has brought about a chaotic condition. As the circuits of the system are now arranged an interruption of one wire may throw out of service as many as forty-nine boxes. The boxes on each circuit, instead of being localized in one region, are scattered throughout large sections of Manhattan Island. Owing to the ramifications of such a circuit, and the multitude of connections in which it is involved, it is not possible to effect repairs in anything like reasonable time, and it is a matter of great difficulty to locate and remove a fault. After reviewing a number of instances where there is a needless number of connections and an unexplainable waste of circuits, the report states:

"The system of wiring and cabling is so criss-crossed, interlaced and tangled that even if, in other respects, the cables were satisfactory, it is certain that it would be unsafe to rely on them."

Electrical tests made upon every circuit entering the central office have shown that the insulation and general electrical condition of the circuits are such that they are at all times on the verge of complete breakdown. Considering the low degree of insulation in the circuits, the report states the following:

"It is a frequent occurrence that relays attached to the fire-alarm circuits fail to operate at the beginning of an alarm, merely exhibiting a slight movement. This is detected by the operator, who, from his long experience, is skilled in working these defective circuits. When this unintelligible movement of the relay is observed by the operator, he immediately proceeds to the relay and changes its adjustment until a coherent signal is obtainable. In this way the first round of an alarm is often lost."

There are something over a thousand terminal boxes in the borough of Manhattan. The report states that the design, construction and present physical condition of these boxes are faulty in the extreme. The internal space and arrangement of the boxes are such that they are altogether unsuitable for housing the large number of cables that have been installed in them. The cables and wires have no support other than that which is furnished by their own insufficient rigidity. The result is that frequently wires come in contact with each other and with the metal parts of the box, thus introducing a constant source of trouble and interruption to the service.

The report calls attention to the numerous instances of serious corrosion of the terminal boxes and also to the very faulty method of making connections from the cable terminals to the conductor terminals. In many instances, lock-nuts are entirely missing and connections must be made in a slip-shod and entirely impracticable manner. The accompanying photographs give a good idea of some of the flagrant instances of bad management in the arrangement of the terminal conductors and the attachment of the conductor terminals.

The introduction of gas pipes into many of the fire-alarm boxes is an added menace to the service, in that leaks often occur, allowing inflammable and explosive gas to fill the terminal. This explosive mixture may become ignited through the passing of a spark, and, in some instances, has been caused to ignite by the striking of matches against the pole. The presence of the gas has also hastened the deterioration in the jumper wires and the connections.

Considering the manhole conditions, the report has this to say:

"While the general cable layout and the method of terminating the cable is, as has already been said, fatally defective, the failure to properly stow the cables in the manholes is such as to present maximum liability of their injury. A thorough inspection was made of a large number of typical cases, and it was found that the fire-alarm cables were strewn over the floors of the manholes or allowed to hang unsupported within them, so that the workmen employed there must necessarily tread upon them or otherwise cause their injury. No distinctive marking was placed on any of the cables."

After detailing many of the circuit troubles due to the general arrangement and electrical and mechanical condition of the cable plant, the report states:

"But the real seriousness of the situation is greater than can be indicated by citing a single case of failure. The trouble records show that frequently as many as ten per cent of all the circuits of the system become seriously deranged in a single day, due not to any one accident or condition, but to many scattered over the entire system. The record of March, 1905, which is given in full in connection with the more detailed report, shows that on the box gong and combination circuits entering the central office (sixty-seven in all), there were seventy cases in which the circuits became grounded, seventy-three in which they became open, and twenty-eight cases where one circuit became crossed with another—a total of 171 cases of grounded, open or crossed circuits in the month. This shows an average of over five and one-half cases of disabled or seriously impaired circuits each day out of a total of sixty-seven circuits. In other words, an average of eight per cent of the fire-alarm telegraph circuits were disabled daily during the month of March. Inspection of the records of other months shows that March was not exceptional."

The report states that the nature of the electrical defects in this cable system is such that they must continue to grow worse. They are so fundamental in their nature, so far-reaching in extent, that it will be impossible to effect complete repairs. The conclusion is that new

cables must be laid and all of the old ones drawn out. All of the fibre-covered cables, constituting seventy-seven per cent of the entire system, will be worthless except as junk. Out of the remaining twenty-three per cent of the cable system, there may be some salvage. It is certain, however, that this cable can not be used in its present location.

Where the fire-alarm telegraph cables run in the high-tension subways, this constitutes an especially dangerous hazard. There is the possibility of destroying not only the apparatus in the fire-alarm boxes, but also that located in the various fire-fighting companies' houses; and there is, as well, the ever-present danger to the combustible woodwork of these houses and the possibility of injury or even death to the operators who have to handle the apparatus.

The alarm boxes are antiquated and defective in many ways. Ninety per cent of the boxes are so designed and constructed that if an alarm for the same fire was pulled from several boxes in the immediate neighborhood of the fire, the result would be a confusion of the signals. To obviate this, a great deal of unnecessary wiring has been done, so that boxes within the immediate neighborhood of one another are not wired to contiguous circuits. This, however, brings about a wasteful and unreliable cable system.

The circuits reaching the alarm apparatus in the fire-fighting companies' houses show the same mixed-up arrangement as the box circuits, wires running in the same cables and being subject to all of the astounding conditions that exist in the terminal posts and manholes. The apparatus, instead of being mounted on fireproof supports, such as slate slabs attached to steel frameworks, is mounted on wooden panels, its parts being enclosed in wooden cabinet work. In many instances the circuits are arranged so that telegraphic communication can be held by the linemen employed in different parts of the city. This is another source of danger, and is liable at all times to create interference with the alarm circuits.

Taking up the details of several alternative propositions, the report describes a system which, after comparison with all the other schemes proposed was found to be the best. In accordance with the finding that the present system must be abandoned in its entirety, the system which is recommended is one which must be built alongside of the old one, and placed in operation before the old one is abandoned. It is recommended that there be installed in the borough of Manhattan a fire-alarm system having a single central office. This will require that a special building should be erected solely for the purpose of the fire-alarm headquarters, and that this building should be located in an open space of such area that the headquarters will be safeguarded against every reasonable contingency growing out of an extensive fire in the neighborhood.

A suitable building to contain the central office fire-alarm apparatus should be about a story and a half high, and about seventy-five feet by 100 feet in horizontal dimensions. Nothing of a combustible nature should enter into its construction. It should not contain any gas pipe, boilers or other sources of explosive hazard. The floor or floors containing the electrical apparatus and exposed wire should be built at such a height above the ground that no possibility of a flood due to a cloudburst, the breaking of a water main, or other cause, would be present. It should contain no skylights, and precautions should be taken to prevent its injury by falling matter from other structures, as in conflagrations or wind storms.

The building should be used solely for the purpose of the fire-alarm central office, so that it would be occupied only by those charged with the duty of operating the fire-alarm system and of maintaining it at all times in good condition. The headquarters should not be by any means utilized as a show place, and instead of exposing the working of the central office apparatus to view, it would be best to so arrange its surroundings as to exclude all except those who are authorized to enter.

The electrical apparatus within the building should be of a fireproof nature, and mounted on non-combustible supports. The usual practice of enclosing the various parts of the apparatus in ornamental cabinet work should not obtain.

Every precaution should be taken in the construction of the building and in providing for cable runways to guard against the formation of flues, which would facilitate the spread of fire.

In the tentative plans for the cable approaches, four lines of subway enter the building from the north, and four from the south. The number of approaches to the central office are thus made as many as are practicable in order to avoid the danger of total interruption.

The idea of subdividing the routes, making each carry a minimum number of circuits, has been followed throughout in planning the cable system.

The cables should be carried, as far as possible, in low-tension subways which carry exclusively low-tension telephone, telegraph and signal wires.

Main feeder cables should be extended from the central office to the various parts of the city. At suitable points along these cables, and at their outer terminals, terminal posts or boxes are located, serving to house the cable conductors where they are brought up from the underground ducts for the purpose of distribution to the alarm boxes and alarm receiving stations in the neighborhood.

By the use of modern, non-interfering successive boxes it is, in every respect, possible to locate the fire-alarm boxes upon each circuit contiguous to each other, and to limit the number to ten. The wires leading from fire-alarm headquarters to the restricted areas occupied by the boxes of the various circuits are contained in feeder cables. The wires in these feeder cables, in order that they may be protected in the greatest possible degree, appear above the ground only at the point at which they branch out to reach the different groups of box circuits in the restricted area. At such points terminal boxes or posts are placed for the purpose of housing the cable ends, and to allow access to the wires for the purposes of testing or of connecting them to other wires. These terminal posts contain facilities for affording access to the wires of the feeder cables, and for connecting these wires to the wires leading to the groups of alarm boxes peculiar to the neighboring box circuit areas.

The report concludes that in a fire-alarm telegraph system constructed in accordance with proper engineering designs, wires should proceed by the most direct routes in feeder cables to the distributing posts adjoining that restricted area in which ten or fewer boxes peculiar to a circuit are located, and from these points the distributing wires should lead, by routes necessarily somewhat circuitous, to connect the different boxes into a complete chain of boxes extending between the posts. Material gain is made not only in the economic construction and maintenance of the plant, but, what is of more importance, the possibility of interruption is enormously reduced. Inasmuch as no more than ten boxes would be upon any one box circuit, there would, in the event of the failure of a box circuit, be thrown out of service not more than that number of boxes.

Concerning the details of the cable system, as already pointed out, the wires in the cables should be insulated with the best type of rubber insulation. These

rubber-covered wires should be bunched together in sufficient number and encased in a substantial lead sheath. The conductors should be of uniform size, of soft copper, of standard purity, and not smaller than No. 16 Brown & Sharpe gauge. The distributing cables should be of the same type, but of smaller numbers of conductors. In the case of the cables extending from station to station between the terminal posts, however, the number of spare wires should be greater in proportion than in the case of the feeder cables. No cable having a smaller number of conductors than four wires should be used.

The greatest care should be taken in the leading of the cables through the manholes, in order that the greatest possible degree of protection may be afforded them.

The fire-alarm cables should be so dis-

FIG. 1.—SOUTHEAST CORNER SIXTY-EIGHTH STREET AND SIXTH AVENUE.

tinctively marked in all manholes that no one could mistake their identity.

The terminal posts in which the feeder cables end and the distributing cables begin should afford ample room for the termination and proper arrangement of all of the conductors leading to and from them. The chamber enclosing these cable terminals should be so enclosed as to be absolutely waterproof under all conditions of weather. It should be inaccessible to the public, and yet afford ready access to the inspectors and trouble men of the department.

The boxes of the system should possess those features as to non-interference and succession that characterize the most modern boxes. The successive feature should be such that with boxes of approximately the same length of signal, as many as four boxes on the same circuit could be pulled simultaneously without any of the signals being lost or in any way confused. All of the breaking contacts in the box should be of platinum mounted on springs of sufficient strength and flexi-

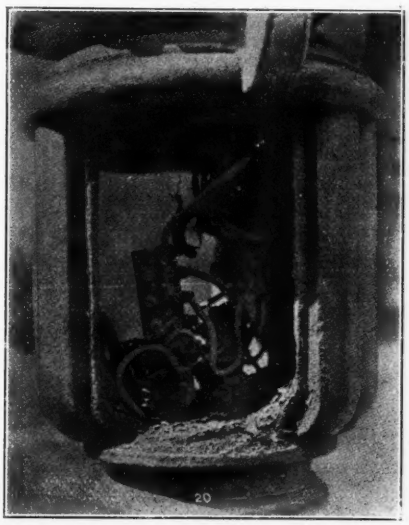


FIG. 2.—SOUTHEAST CORNER OF PECK SLIP AND PEARL STREET.

bility to assure permanency of adjustment. Instead of ordinary tap bells, a substantial telegraph sender should be employed, similar to the type used in the ordinary Morse telegraph.

The signaling mechanism at the apparatus houses, by means of which alarms

FIG. 3.—SOUTHEAST CORNER OF FRANKLIN AND CENTRE STREETS.

and other signals are received by the fire-fighting companies, should be in duplicate, the two sets being on different circuits. The gongs of both sets should be of the quick-acting type, and the entire mechanism of the greatest possible simplicity, both as to function and mechanical arrangement.

Those circuits over which alarms are first received should have no other mechanism included in them at the department houses than the signal receiving devices. The circuits over which the confirmation of alarms are sent to the department houses may be used as combination circuits, and may be provided with suitable Morse apparatus. Automatic registers for both the initial and confirmation alarm circuits should be provided at each apparatus house, upon which will be recorded all alarms received over each of these circuits.

In the system recommended, if properly maintained, a condition of trouble on a circuit will be an abnormal one, and arrangements will be provided at the central office for indicating automatically and at once when any circuit is either

FIG. 4.—SOUTHEAST CORNER OF SIXTY-EIGHTH STREET AND THIRD AVENUE.

grounded or open. Apparatus will be provided also for each circuit, by means of which a line that gives indication of trouble will be at once disconnected by the operator from the regular board and switched to special apparatus at what may be called a wire chief's board. This board might be called, untechnically, a "hospital" board, since it would have to deal only with those lines that are not in good condition and with the location and removal of the trouble on such lines.

All current for the operation of the system should be supplied from suitable storage batteries, and these, in turn, should be charged from dynamos at least in duplicate. There should be at least two entirely separate sources of power for these dynamos, so that the complete break-

down of the charging plant would be an impossibility.

Leaving out the cost of obtaining the necessary real estate, but including the cost of the central office building, the new fire-alarm system could be constructed and placed in operation for about $1,400,000. This figure, it should be understood, is an approximate estimate, and only provides for a system having the present number of stations. The general cable system and central office, however, are so planned that a large margin for growth is allowed, so that additional boxes may be added to the proposed cable system without other expense than that for apparatus and for connecting it to the general underground system.

The added expense thus involved in the purchase and placing of about 500 additional box stations, bringing the total number of boxes in the island of Manhattan up to about 1,500, is $225,000, thus making the total cost, exclusive of the necessary ground for the central office, about $1,625,000.

The accompanying illustrations are interesting as showing the condition of some of the fire-alarm terminal boxes, and the wonder is that the apparatus has been able to convey any signals at all.

Fig. 1, designated as No. 15 in the report, is a terminal box at the southeast corner of Sixty-eighth street and Park avenue. This shows a bunch of cross-connecting wire which was placed in the terminal three days before the photograph was taken. The wires are spliced without tape, and badly tangled.

Fig. 2, designated as No. 20 in the report, is a terminal box at the southeast corner of Peck Slip and Pearl street. This shows quantities of iron rust and scale.

Fig. 3, designated as No. 24 in the report, shows a terminal box at the southeast corner of Franklin and Centre streets. This shows two cables without terminals. The conductor wires are spliced to cable wires. A quantity of iron rust and scale is in the box, and it is in very poor shape.

Fig. 4, designated as No. 28 in the report, is a terminal box at the southwest corner of Sixty-eighth street and Third avenue. Twelve cables are terminated in this box.

New York Electrical Society.

The opening meeting of the New York Electrical Society will be held at the Edison station, Twenty-seventh street near Sixth avenue, on Monday, October 23. Mr. Peter Cooper Hewitt will lecture on "Electrical Reactions of Gases."

The Commercial Cable Company's Fifth Atlantic Cable.

The Commercial Cable Company's fifth Atlantic cable from Canso, Nova Scotia, to Waterville, Ireland, was completed and put in operation on October 6. This makes seven trans-Atlantic cables worked in direct connection with the lines of the Postal Telegraph-Cable Company. All of them are duplexed so that their combined capacity is fourteen messages at one time.

The new cable is the best and most expensive submarine cable ever laid. It was manufactured by the Telegraph Construction and Maintenance Company, of London, having been begun in March, 1905, and finished and shipped on board the construction company's steamer Colonia on August 3.

Atlantic cables are always laid from west to east because the prevailing winds in the summer months on the Atlantic are from the West and ships make much better weather going eastward, consequently the Colonia sailed direct from England to America, arriving off the coast of Nova Scotia on August 16, and landed the heavy shore end of the cable on the morning of August 18. Moving out from the shore she struck a rock and remained fast on it for four days. The injuries she sustained compelled her to go into drydock at Halifax with 2,300 miles of submarine cable aboard. She was the largest and heaviest ship ever taken on that drydock, exceeding by thousands of tons the United States battleship Indiana of 10,000 tons, which went into drydock there a couple of years ago. Repairs were made and the Colonia took the sea again. On September 23 she laid her course from Canso, Nova Scotia, paying out cable. On September 28 she passed through a hurricane in mid-Atlantic, although on that day the weather on both sides of the Atlantic was reported fine, with gentle winds. On October 3 she arrived without mishap at a point 187 miles from the coast of Ireland, where the final splice was to be made between the cable that she had paid out from the American side and the 187 miles of cable previously laid westward from the Irish coast by the steamship Cambria in the month of June. The weather was heavy and the Colonia was compelled to heave to for several days awaiting smoother seas to enable her to make the final splice—which was made on October 6.

At some points the cable was laid at a depth of nearly three miles below the surface of the sea. The quantities of material used in the manufacture of the cable were 1,411,200 pounds of copper; 799,688 pounds of gutta-percha; 16,845,000 pounds of brass tape, jute, yarn, iron wire and preservative compound.

The signaling speed of this cable is fifteen per cent greater than that of any other cable of equal length in the Atlantic. The cost of the cable varied from $1,000 to $6,000 per mile, according to the character of the ocean bed and depth of water, the great variation in cost being due to the different diameters and weights of the sections of the cable; the cable which is laid in the deepest water being the lightest for the important reason that it would be impossible to retrieve a heavy cable from deep water because of the enormous pressure. Cable in deep water is practically safe from mechanical injury and therefore does not need to be so strong, so that the sections laid in deep water are of small diameter and less cost. The sections laid near shores are of massive construction and very expensive. In the neighborhood of the fishing grounds off the coast of Newfoundland, a type of cable midway between deep water and shore end cable is used. This intermediate size is made strong to resist injuries from the anchors of fishing craft, the most prolific source of danger to submarine cables. This intermediate type is made just heavy enough to afford reasonable prospect of retrieving it in the event of its being damaged by the anchor of a fishing vessel. The completion of this cable greatly increases the Postal system's already large facilities for ocean cabling.

Independent Telephone Men Organize.

District No. 1 of the Missouri Independent Telephone Association, comprising ten counties in northwest Missouri, was organized at the Hotel Metropole, St. Joseph, Mo., September 29. The following officers were elected: president, H. E. Ralston, Maryville; vice-president, S. D. Thompson, Cameron; secretary and treasurer, F. G. Funston, St. Joseph. Mr. Funston, who is superintendent of the Citizens' Telephone Company, of St. Joseph, will be the active representative of district No. 1, and will give his attention to making the organization effective. A constitution and by-laws similar to those already adopted or to be adopted in the other nine districts was formulated at the opening session. James F. Barnett, of Memphis, Mo., secretary and organizer of the state association, presided at the session.

THE DISTRIBUTION OF POWER.[1]

BY W. E. AYRTON.

Probably, like myself, you have heard vague comparisons made between the power of the Victoria and the Niagara falls. Now, what is the true comparison? The flow at Niagara varies at different times of the year from 62 to 104 million gallons per minute. At the Victoria falls the flow can be one-twelfth of the smaller number—for it is so now and some authorities, well acquainted with the spot, say that at the end of another three months the flow will only be half of even that. The mean available drop at Niagara is about 160 feet; at the Victoria falls 380 feet. Hence, while the minimum Niagara flow represents about 3,000,000 horse-power, the present Victoria flow represents about 580,000 horse-power, or only about one-fifth of the preceding. Further, if those who predict the flow of the Zambesi sinking to something like two and a half million gallons per minute in November are true prophets, the Victoria falls will then only give out about 300,000 horse-power, or, say, one-tenth of the minimum that Niagara produces. In all that precedes I have taken the full power of the direct drop in each case—that is, I have assumed in each case the intake to be close to the main drop, and I have deducted nothing for inefficiency of machinery.

Now, how exactly does the efficiency in the electric transmission of power depend on (1) the pressure, (2) the power transmitted, (3) the length of the transmission line, (4) the resistance of the conductors composing it?

The very simple approximate formula connects these quantities:

$$\left.\begin{matrix}\text{Percentage loss}\\ \text{of power on the}\\ \text{road.}\end{matrix}\right\} = \frac{\text{Horse-power transmitted}}{3\ (\text{thousands of volts})^2} \times \text{miles} \times \left\{\begin{matrix}\text{Resistance per mile}\\ \text{of all the conductors}\\ \text{in parallel.}\end{matrix}\right.$$

This formula tells us that as long as the electric pressure is limited to some 10,000 or 11,000 volts, a pressure boldly used as early as 1897 by the Rand Central Electric Works and at the Moodie mines, near Barberton, but the one that is still the maximum sanctioned in Great Britain, it will not be possible, even with a pair of conductors of good copper, and each as thick as three-quarters of an inch in diameter, to transmit more than about 6,000 horse-power, or to transmit that power more than about ten miles, without the loss on the road exceeding ten per cent. The actual efficiency will, of course, be less than ninety per cent, since there will also be losses in the machinery at each end of the transmission system. Not only have various successful 60,000-volt transmission schemes been carried out, but the Kern River Power Company, in California, is constructing one for transmitting 4,020 horse-power over 110 miles at 67,500 volts. When the new railway—Brakpan to Witbank—is completed, 110 miles will be twenty more than will separate the Rand from the coal fields at Witbank—fields that produce such good coal that the Central South African railways have contracted to purchase 84,000 tons during this year at 6s. ($1.44) per ton at the pit's mouth. Now, if six wires were used like those now employed by the Rand Central Electric Works, then, at 67,500 volts, 9,000 horse-power might be put in at Witbank and only five per cent lost on the road; that is, about 8,950 horse-power delivered on the Rand. But the insulators would have to be placed much farther apart than on the existing Rand posts to prevent the starting of a brush discharge between the wires.

You will now grasp why in 1895, ten years ago, it was a bold and pioneering policy to equip the Rand Central Works for 10,000 volts and to use 13,000 volts during times of full load, and why in 1905 the recommendation of some advisers to distribute power at only 10,000 volts to the proposed substations of the contemplated fifty-seven miles of electrified railways—Springs to Randfontein—is most retrograde of those advisers to the railway. In 1879 a firm of electrical contractors, well known then and equally well known now, told me that they had been asked to tender for the construction of an electric transmission system to convey a comparative small amount of power ten miles. But since they considered that they could not possibly hope to deliver more than half, while, in practice, they feared that they would only succeed in delivering much less, the proposal had to be ranked with the exploits of Gulliver and Baron Munchausen, and so even that firm declined to tender. To-day, twenty-six years later, electric power is, from an engineering and from a business point of view, being successfully transmitted 232 miles.

Next I come to a very important question, and one that merits far more consideration than it has yet received. There are two kinds of electric current—direct current and alternating current. Now which kind of electric current should be used for the distribution of power over long distances? Practically, every electrical engineer will at once reply: alternating, of course. Well, I am going to preach heresy.

The alternating current has undoubtedly the great advantage that a motor can be constructed with no rubbing electric contacts, every wire may be permanently soldered in position, a condition of considerable importance in dusty places like mines. Another advantage possessed by an alternating current is, that an alternating-current dynamo can be constructed to produce a large horse-power at a high voltage; and further, this alternating voltage can be transformed into a still higher one without the use of moving machinery. Contrasted with this, no single large direct-current machine has ever been constructed to generate more than about 3,500 volts, and no means is known for efficiently converting a direct-current voltage into a higher or a lower one without the use of moving machinery.

So far then my case seems weak! The advantages of using great electric pressures we have seen. Are there any disadvantages? This is a disadvantage: the risk of piercing the insulation! See how thick the insulating material has to be on cables, how far apart the conductors have to be placed, even when the cable is intended for only 10,000 volts. But does this consideration supply any argument for, or against, the use of one kind of current rather than the other? Small current and high pressure must be used for the economical transmission of power over long distances, whether the current be alternating or direct, I agree, but, I submit that, while from the point of view of economic transmission, 60,000 volts alternating means exactly the same as 60,000 volts direct, from the point of breakdown of the insulation, 60,000 volts alternating is as bad as 85,000 volts direct, indeed, may be worse than 100,000 volts direct. For an alternating current consists of waves like the waves of the sea. In a storm the waves may be running mountains high, and yet the average depth of the sea remains the same as in a calm. The mean electric pressure may not be very large, and yet the crests of the waves may be so high, and the troughs so low, that its strength can not stand the electric tossing.

But there are other disadvantages in the use of alternating current. One of them is the increased drop of pressure in an inductive circuit when supplied from

[1] Abstract of a lecture delivered at the meeting of the British Association, Johannesburg, August 29.

an alternating source of supply instead of with direct current. This self-inductive effect, as it is called, is small, if the going and return conductors be straight, short and near together. But, if the distance over which the power is to be transmitted be long, the wires obviously can not be short, and if, to obtain economy, high electric pressure be used, the wires can not be put very near together, since that would lead to a brush discharge through the air from one conductor to the other, producing leakage.

But that is not the whole indictment against the use of alternating current for long-distance transmission. Leakage from wire to wire can be rendered small, but still, if the current be alternating, it always flows along the wires, even if all the apparatus at the distant end be entirely disconnected from them. The very first thing that struck Ferranti, the Brunel of electricity, when he commenced transmitting power with alternating current at 10,000 volts pressure from Deptford to London was that the current flowing into the system at Deptford was as large during the daytime, when practically no lamps were turned on in London, as during the evening, when many were glowing. And, in the case of the 150 miles transmission at 50,000 volts, by the Bay Counties Power Company, in California, it was found that to charge even the aerial lines as a condenser required forty amperes, so that the current flowing into the system remained practically unchanged when the useful load was decreased from several thousand horse-power down to nought.

Now, this is the very opposite of the effect we previously noticed, for in that case it was the alternating pressure that failed to send the current into the transmission system. Surely, then, the one effect is a correction of the other. That is so, and I will give you a practical illustration.

[The lecturer then showed experiments illustrating the neutralizing effects of capacity and inductance and showed how resonance is established in electric circuits.]

Much damage has been done to electric cables used for the distribution of power by the unexpected high pressures produced by resonance in alternate-current circuits. A cable may have been tested at twice or thrice the working pressure and passed as satisfactory. But if there is a liability of a pressure being applied, which, as you see, may in somewhat extreme cases be twenty or thirty times the working pressure what avails it, there being a factor of safety of two or three—disaster must follow.

Now, with direct current for long-distance transmission, there is no question about the electric pressure at the top and bottom of a wave being much greater than the mean pressure, no question about self-induction reducing the current—no objection, therefore, to putting the conductors as far apart as the risk of brush discharge may necessitate—no question about capacity current, no resonance troubles, etc.

You are thinking, if the arguments were sound, the direct-current system would have been already employed for long-distance transmission. Well, but it has! Power up to 3,000 horse has been transmitted with direct current, at 14,000 volts, from Combe Garot to Le Locle and La Chaud de Fonds, round a circuit thirty-two miles long, 4,600 horse-power has been transmitted with direct current at 23,000 volts, thirty-five miles from St. Maurice to Lausanne, and a transmission system for 6,000 horse-power at 60,000 volts, over 114 miles from Moutiers to Lyons, is in course of construction. Another advantage that is possessed by all these examples of direct-current transmission carried out by M. Thury, is that it is the current that is kept constant, and the electric pressure that is automatically raised, when the demand for power is increased, whereas, with the ordinary alternate-current system, it is the pressure at the lamp end that they aim at keeping constant and the current that varies automatically with the demand for power.

Now, it is far more easy to maintain the constancy of the current flowing round a long circuit than to prevent the bobbing up and down of the electric pressure at the distant end of a long transmission line, and that irritating dancing of the lights, which Johannesburg is so familiar with, would be particularly difficult to avoid if the transmission line were long and the electric pressures at its two ends differed by some thousands of volts. Constant current has also its well-known disadvantages, but these would not come into play if the constant current were not taken into houses, mines, etc., but used to drive motor-generators in substations, the dynamo portion of the motor-generator being of any type desired.

The pioneering development that American boldness, enterprise, initiative and originality have brought about in the electric distribution of power, combined with the extraordinary commercial success that it has won on both sides of the Atlantic, have made people ask, "is such an industrial revolution in store for South Africa?" At first sight one is inclined to answer, "no!" This country is dotted with coal fields—coal fields blacken the map, and the produce of some of them is reported to be nearly equal to the best Welsh coal in quality. When, on the one hand, one hears that good coal is brought from Witbank and delivered to the mines on the Rand at 13s. ($3.25) a ton, and that even this price will be lowered on the completion of the new railway from Witbank to Brakpan, one feels that long-distance electric distribution has not much chance—indeed, a proposal to burn slack coal at Vereeniging, only thirty-three miles from Johannesburg, and electrically distribute the power on the Rand, fell through. On the other hand, when one finds that at the Wankei coal fields themselves large coal costs 15s. ($3.75) a ton at the pit's mouth, and that Salisbury pays 36s. 5d. ($9.10), Umtail 43s. 6d. ($10.87) and Kimberly 67s. ($16.75) per ton, one feels that electric distribution in this country possesses possibilities.

South Wales has many coal mines—cheap slack coal lies heaped at the pit's mouth. Let me put this question to you: "if an electric supply distributing company were to start in South Wales to obtain their electric energy, not from waterfalls, mark you, but from coal brought to their generating stations from coal mines, would you anticipate, I ask, that such a company would obtain customers for their electric energy at the coal mines themselves?" "No, emphatically no," you would reply, for that would be taking coals to Newcastle with a vengeance. And yet, within four years since that South Wales company was merely applying to parliament for an act to enable it to establish a distribution of power system, fourteen of the largest colliery companies and thirty of the mines are taking power at about one cent per horse-power-hour, the demand three months ago having reached 13,000 horse-power, and rapidly increasing.

That the North-Eastern Railway, and such a large number of manufactories along the Tyne, should, as seen from that other diagram, take power from the Tyneside Electric Power Supply Company—which also has been but four years in existence—was perhaps to be expected, but that coal mines should obtain power by the burning of the product of distant collieries resembles at first sight the method of earning a living attributed to a certain village—*viz.*, by taking in one another's

washing. But this result is but an example of the subdivision of labor. At a coal mine, getting coal, and at a gold mine, getting gold, is the business; and at both, especially in the early days of sinking the mine, it should pay better to buy electric energy from an outside source than to generate the current on the spot.

Niagara sends 24,000 horse-power to Buffalo, thirty miles away, and sells it at 1.4 cents per horse-power-hour to an eight-hour user there—a price which is not cheaper than the total cost of generating a horse-power-hour at Buffalo with a large steam engine. But tapping electric wires to obtain any amount of power that may be needed, and just at the time that it is required, is far more convenient than erecting steam engines and getting up steam, and certainly cheaper in the early days of sinking a mine.

It has been objected that the total steam-power curve of all the gold mines on the Rand shows the same sort of falling off during the hours 4 to 7 A. M., and 5 to 8 P. M., and, therefore, that apart from using larger and more economical engines, and from diminishing the cost of superintendence for the energy sent out, there would be no saving by supplying many mines with electric power from a common generating station. But if there be a railway in the neighborhood, largely used by workmen, the slack hours of the mines will be the busy hours on the railway. Hence, if that railway be run electrically from the same generating station, the load curve will be flattened and much improved.

On the Rand, however, there is an indisposition apparently to utilize distribution of power on a large scale. The labor conditions in this country are certainly peculiar. Mr. Denny, in his book on "Deep Level Mines of the Rand and Their Future Development," expresses this opinion: "it has, however, been fairly conclusively proved that in average conditions hand labor is both speedier and cheaper than machine drilling." Contrary to American and Australian experience, it may be true that in this country white men and machinery may be dearer and slower than black machinery and man rolled into one. But it makes one uncomfortable, even unhappy, to think it possible, for it means that the muscular machine is more valuable than the inventor's brain.

Another objection felt by mine owners here to investing much capital in machinery is the somewhat uncertain character of their business, and a third against a mine depending for a supply of power on an electric current coming from a distance is the climatic conditions. South Africa has various unique big things, but it has not a monopoly of big atmospheric disturbances, and these disturbances do not prevent electrical distribution of power schemes being pushed forward by leaps and bounds in the other three quarters of the world. During my short stay in this country I have been giving this matter much consideration. Without stopping this evening to discuss the subject in detail, I may mention that, after the admirable work of Mr. Wilms, Mr. Spengel, Mr. Heather and others here, on the improvement of lightning arresters for electric transmission lines, I think I also see my way to putting a nail into the coffin of these bugbear lightning troubles.

But, while advocating electric transmission of power, I should not start by constructing a transmission line from the Victoria falls to Johannesburg. And I say that, not because I am of opinion that it could not be made to work, nor that, if direct current were used, it could not be relied on to give as satisfactory results as, or even better results than, some shorter existing ones on the alternate-current system, but because it does not appear to me that along the route there is at present sufficient demand for power to justify as large an expenditure of capital as would be compatible with a transmission line 586 miles long as the crow flies, and which would be no less than 745 miles long if made along a railway through Pietersburg and Gwanda, should that missing stretch of railway between these two places ever be constructed.

Those who hold the opposite view will doubtless urge that when the Cataract Construction Company, of Niagara, acquired in 1890 the right to use 100,000 horse-power, and a further right to subsequently use another 100,000 horse-power, it required an extraordinary belief in the future of electrical engineering to expect that 200,000 horse-power could ever be distributed at a price that could compete with large local steam engines. And now what is the state of things? The total electrical horse-power that could be sent out from these various Niagara power-houses when completed will approach 700,000 horse-power, and represents about thirty per cent of the water going over the falls at the time of minimum flow.

Now what has caused this vast development in the distribution of power; what is the secret of this extraordinary success? It is that in the immediate neighborhood of the falls there have grown up works which take some 60,000 horse-power, works which not only want cheap power, but power in an electric form for electro-chemical processes, and need it in an undiminished amount day and night, week-day and Sunday.

Now, what is the prospect of such a steady load growing up locally within, say, three miles of your falls? Even on the spot it is difficult to obtain trustworthy information; by some it is said that one condition of the contract for the construction of the railway, which is being pushed forward to the copper, lead and zinc fields at Broken Hill, 400 miles to the north-east, is that 100,000 tons of the ore must be sent to Beira yearly for ten years. If true, then that ore will not be available for reduction at the falls.

There is a convenient spot for a power station near the water at the end of the second gorge—all the Niagara power stations are on the top of the falls with the exception of that of the Ontario Power Company—and it is the latter method of construction that would be the most suitable to follow at a Victoria power station.

Electrical Inspectors' Meeting.

The first meeting of the Western Association of Electrical Inspectors was held in Chicago, Ill., October 5, in the rooms of the Chicago Underwriters' Association. The membership is made up of representatives of insurance organizations and city inspectors. At the opening session there were considered the changes to be recommended in the National Electrical Code at the meeting of the executive committee in New York in December. The organization aims to secure standardization of inspection rules in the West, and the enforcement of rules for safeguarding life and property.

The Horse-Power of Steam Turbines.

"An instrument for finding the power of a steam turbine," says the *Mechanical Engineer*, London, "has been designed by Mr. Johnson, of Messrs. Denny & Brothers, Dumbarton. The action of the instrument is said to depend on the measurement of the torsional deflection of a given length of shaft, which will, of course, vary with the power transmitted. Such measurements must, however, be very delicate to be of value, while the deflection will obviously depend on the nature of the material, as well as the twisting force. It is difficult, therefore, to see how an exact standard of comparison can be established, and it will be interesting to know the results of the tests which, we understand, the admiralty has recently been making with the instrument on board a torpedo destroyer."

THE ELECTROPLATING OF ALUMINUM

BY A. G. GIROUX.

As far as plating of aluminum is concerned, it is, of course, a very well-known fact that aluminum is a very capricious metal in many a way. However, as regards the plating of it, there is no mystery. Of course, in order to plate the metal successfully, the operator, no matter how good he is, will have to practise before he is able to master the operation. Let me say that in plating no copper solution (alkali), made to be used with a strong current, is of any use. The operator needs a good conducting solution which will run with a slow current, and a solution that contains cyanide only will not do. It must contain good conducting salts such as carbonate and bisulphite of soda. This is a very important matter in the plating of difficult metals such as aluminum.

A solution which I would highly recommend is composed as follows:

Distilled water	10 quarts
Crystallized carbonate of soda....	8½ oz.
Crystallized bisulphite of soda...	7 "
Neutral acetate of copper.....	8½ "
Cyanide of potassium 98°.....	8½ "

The sodium salts should be used in a crystallized form and the operator should be sure that the acetate is neutral. The solution is made up as follows: in seven quarts of hot water dissolve the carbonate of soda, and add the bisulphite of soda a little at a time. Crush the acetate of copper and add it in small proportions with vigorous stirring. The cyanide of potash is dissolved in three quarts of water and, when the first solution is cold, it is mixed with it. The mixture is well stirred, boiled and filtered. This bath will plate heavily and only a small current 0.4 ampere, with a tension of three volts for a surface of about fifteen square inches, is required.

A very important consideration is the preparation of the object before it goes to the bath. The operator should get ready to get all his work, which is to be cleaned, through in a hurry, in the same manner as is done with steel. The work must not lie about, because aluminum is just as easy to oxidize as steel, although it may appear very white. In a moment it will take a grayish tint, which surely will prevent a successful plating. The article to be plated is left some time in a solution of cyanide of potassium of eight ounces to the gallon of water. It is then brushed with pumice thoroughly in and out. When it is perfectly clean, it is dipped into hot potash until gas bubbles are evolved. It is then rinsed in cold running water and then in a solution of corrosive sublimate, made up of water, corrosive sublimate and cyanide of potassium. After this it is dipped directly into hot potash, just long enough to see the bubbles appear. It is then dipped in water again and once more into corrosive sublimate and then directly into the plating bath.

One of the most important parts of the operation is to fix the current in a proper proportion to the size of the work. There must not be a single bubble seen through the solution, as otherwise the object is sure to fail. If the operator has much work to do it would be absolutely necessary to provide himself with an indicator such as an ampere and voltmeter and this would easily put him in the right way. As I said before, if the operator works by the rule of thumb he will certainly have to practise, because the plating of aluminum is a hard operation for a beginner. I have worked it with success and I am sure that if the operator sticks to it he will certainly find a good solution.

A quick worker is necessary because there is a certain danger of destroying the finish of the metal. It is, therefore, necessary to watch the potash dip, as too long a dipping would cause the object to appear heavily frosted. In general, as I said above, when a piece is started once it is better to complete it right away. In one word success is due to the perfect cleanliness of the object. I would recommend the operator not to potash first as in ordinary plating, but to clean the work exactly as I described above and watch the current, so that it will be just strong enough to plate easily, and to avoid to plate with evolution of gas.—*The Metal Industry.*

The Literary Instruction of Students of Science.

In the course of his address upon "University Education and National Life," before the Educational Science Section of the South Africa meeting of the British Association, Sir Richard C. Jebb, president of the section, referred to the science student, as follows:

"One of the urgent problems of the higher education in our day is how to secure an adequate measure of literary culture to those students whose primary concern is with scientific and technical pursuits. Some of the younger English universities, which give degrees in science, contribute to this purpose by providing certain options in the science curriculum; that is, a given number of scientific subjects being prescribed for study with a view to the degree of B. Sc., the candidate is allowed to substitute for one of these a subject taken from the arts curriculum, such, for instance, as the theory and practice of education. This is the case in the University of Wales and in the University of Birmingham; and there are indications, I believe, that this example will be followed elsewhere.

"Considering how hard and sustained is the work exacted from students of science, pure or applied, it seems important that the subjects from which they are to derive their literary culture should be presented to them, not in a dryasdust fashion, not chiefly as subjects of examination, but rather as sources of recreation and changes of mental activity. From this point of view, for British students of science the best literature of the English language offers unequaled advantages. It may be mentioned that the board of education in London is giving particular attention to the place which English literature should hold in the examination of students at the training colleges, and has under consideration carefully planned courses of study, in which portions of the best English writers of prose and of verse are prescribed to be read in connection with corresponding periods of English history, it being understood that the study of the literature shall be directed, not to philological or grammatical detail, but to the substance and meaning of the books, and to the leading characteristics of each writer's style. If, on the other hand, the student is to derive his literary culture, wholly or in part, from a foreign literature, ancient or modern, then it will be most desirable that, before leaving school, he should have surmounted the initial difficulties of grammar, and should have learned to read the foreign language with tolerable ease.

"When we look at this problem—how to combine the scientific and the literary elements of culture—in the light of existing or prospective conditions in South Africa, it appears natural to suppose that, in a teaching university, the faculty of education would be that with which literary studies would be more particularly connected. And if students of practical sciences, such as engineering and agriculture, were brought together at the same centre where the faculty of education had its seat, then it should not be difficult, without unduly trenching on the time demanded by scientific or technical studies, to provide such students with facilities for some measure of good literary training."

The Death of John I. Sabin.

It is with great regret that a host of friends and acquaintances will receive the announcement of the death of John I. Sabin, president of the Pacific States Telephone and Telegraph Company, which occurred on Tuesday evening, October 10. Mr. Sabin was one of the best known telephone and telegraph men of the United States, and from the beginning was the head of the telephone business on the Pacific coast. He achieved considerable prominence in electric telegraph circles in the East prior to his departure for California in 1866. It was in 1866 that Mr. Sabin first reached California on his way north with the Collins expedition which was to establish telegraphic communication by land lines to Alaska, thence across the intervening space of sea islands in Siberia and Russia. Upon the abandonment of that undertaking, he selected San Francisco, Cal., as his permanent abode,

MR. JOHN I. SABIN.

where he entered the service of the Western Union Telegraph Company, receiving the appointment of manager of the supply department. From this position he was promoted to that of superintendent of the American District Telegraph Company, his work in every position being uniformly successful.

Mr. Sabin was quick to realize the advantages of telephone communication, and by his very energetic work and progressive methods succeeded in amassing a fortune in the development of telephony. He established various classes of telephone service and was the pioneer in many developments of this nature. Quite recently he became interested with Mr. Louis Glass, vice-president of the Pacific company, in the development of the telephone and telegraph situation in the Philippine Islands.

ELECTRICAL MINING NOTES.

THE AUTUMN MEETING OF THE INSTITUTE OF MINING ENGINEERS.

BY SYDNEY F. WALKER.

Two subjects, each of great importance in themselves, were prominent at the autumn meeting of the Mining Institute, recently held in Manchester and the neighborhood. The question of taking power for working the collieries from power stations, or from their own generating station, and the question of earth in collieries were brought up. The first question was brought before the institute by the engineer of the Lancashire Electric Power Company in the form of a paper, the members afterward visiting the station. Mr. Gamlen, the author of the paper, prefaced his remarks with an historical résumé of the development of electric lighting and power stations which was not always correct. The Jablochoff Company, for instance, was given the credit of the early generating station on the Holborn viaduct, where incandescent lamps were supplied for street and private lighting, and also for the supply of arc and incandescent lighting from Belvidere road, Lambeth, for the Strand and the neighborhood. The former of these was put up by the Edison company for the purpose of showing what Edison incandescent lamps could do, and the latter was in the hands of the Anglo-American corporation, the owner of the Brush patents. He also appears to be under the impression that the very general adoption of single-phase currents by the towns which took up electric lighting in those days was because it was simpler; whereas it was merely a case of fashion. The first successful town lighting stations were Brighton and Eastbourne. The point, however, of interest to mines generally is whether current can be generated more economically by large power stations than by the collieries themselves. Mr. Gamlen's view naturally was that it could be. I have consistently held the contrary view, where the colliery or the iron company with collieries has a certain demand, and I expressed that view very forcibly in the discussion. I put the matter to the mining engineers thus: every mining engineer knows that he can only draw a certain quantity of coal from one pair of pits. As soon as that limit is reached, if he wishes for a larger output, he has to sink more pits. Up to that output every ton of coal drawn lessens the working costs upon the whole output, but immediately the limit is past he has to commence again, and for some time his total costs will be above those with only one pair of pits. The limit is constantly going up, with improved appliances, but in all cases there is a limit that can not be passed, where economy ceases. It is the same with power stations, there is a limit beyond which it is not economy to go. That limit is also rising, and the power stations that are put down now will have a higher limit than those that were put down some years back. But where there are a group of collieries or, as so often happens both in England and elsewhere, a large iron firm also possesses its own collieries, the quantity of electricity required by the concern for its own use is much more than the economical limit of the power station that wishes to supply it. The question of generation is, after all, only half the problem. There is the question of distribution, and in this connection I quoted, at the discussion, some recently published figures of Glasgow, in which distribution figures for £49 per kilowatt out of a total of £86.79, plant accounting for only £19.47. Making every allowance for the fact that Glasgow has been built up as the requirements developed, and that the power stations that are put down now will have the advantage of the experience gained by Glasgow itself, among others, the above figures are of considerable significance. The area covered by the Glasgow corporation is a pretty large one, and the units in its power stations are also large, 5,000 horse-power, while it has also adopted fairly high-tension for the outside distribution.

Mr. Gamlen retorted that Glasgow proved his case, as the mains had been laid out in a patchwork system, and that his mains would not cost anything like £49 per kilowatt. The Lancashire power station is generating at 10,000 volts, three-phase at the generators, which are driven by Curtis turbines, the current being taken from the station by naked overhead conductors, carried by triple petticoat insulators, to a convenient point, where they are connected to underground triple-cored, three-phase paper and lead-covered cables. The generating station is in an ideal situation, close to a colliery, from which the coal is brought direct by a private siding, and on the banks of the Irwell, the river that farther on divides Manchester and Salford. Town water is used for raising steam, and the water from the Irwell for the circulating condensing water, the suction of the cir-

culating pumps being so arranged, with reference to the delivery, that the engineers claim to have secured a syphon action; the circulating pump having only to make up the frictional and other charges not provided for by the syphon. It is doubtful if there is much in this, but an unlimited supply of circulating water is an immense boon. On the other hand, the Irwell, like all rivers in manufacturing districts, is badly polluted with sewerage, and other matter of all kinds, and the water side of the condenser pipes may feel this seriously in the vacuum.

A case was brought under my notice, a short while since, where the vacuum suddenly fell very considerably, and it was found to be caused by the deposit of a film of grease on the condenser pipes. The grease having a high thermal resistance, the heat did not pass from the steam to the condensing water as it should have done.

They have a very neat arrangement for delivering the coal from the railway wagons into the coal bunkers at the Lancashire power station. The railway wagon has a bottom door, and the coal falls into a specially constructed wagon below, standing upon a railway leading to the bunkers at a very slight inclination, so that it runs down by gravity. Near the entrance to the bunkers there is suspended from the line a triangular-shaped box made to contain stones or any convenient weight. The momentum gained by the coal wagon on its way to the bunkers enables it to carry the weight along with it, and to lift it up, when the coal wagon tips over in the operation of unloading, which it performs automatically. The kick of the weight when the wagon resumes the horizontal position is sufficient to send the empty wagon to the other end of the line, from which it started, the weight being left at the point where it was picked up. The arrangement enables only one line of rails to be employed on a light bridge running from the siding to the power-house, the latter standing some feet below the level of the railway. It is a clever adaptation, it will be seen, of the switchback railway.

The paper on "Earth in Collieries," with especial reference to the recently issued departmental rules, was by myself. The gist of the rules is that all cables carrying currents above 250 volts must be armored, or the equivalent, and the armor and all metal work connected to earth. During the whole period of the development of electricity in mining, I have opposed the use of armor, and have pointed out the difficulty of earth in a coal pit, recommending that earth should be kept out of the service altogether, and my paper was intended to draw attention to the fact that danger of shock was not neutralized where you could get good earth, while in a large and increasing number of collieries it will be impossible to get earth. In America you call it "ground," which is as usual a very much more expressive term.

The North of England Institute of Mining and Mechanical Engineers, which is affiliated with the Durham College of Science, had some measurements taken, under the supervision of Professor Stroud of that college, of the electrical resistance of coal, the roof and floor between which it lies. The results were rather startling. Coal comes out practically an insulator, 30,000 to 80,000 meghoms per cubic centimetre, the floor, or "thill" as it is called, which is usually clay, being very much less—from 3,000 ohms up to 100,000 ohms—so that all "ground" conduction will be by the floor, the strata upon which the coal lies. Now the collieries in England may be divided roughly into two groups, those which have water in the workings, and those which have not, and these again mean shallow and deep workings, usually. Water is found in many collieries in shallow workings, while the deeper mines, those that are necessarily more and more in evidence as the upper seams are being worked out, are dry and dusty. In the wet mines "ground" is easily obtained. The roads, workings, etc., are sloppy, and are making good electrical connection with the rising main from the dip pumps. But my contention is, and it was borne out in the discussion, that though "ground" is easily obtained in those collieries, safety does not always follow. If, for instance, one of the armored cables makes connection between its armor and its conductor, a completely new set of conditions arise, and it is perfectly possible for a man standing on wet ground to get a severe shock by touching some part of the armor of one of the cables. On the other hand, in the dry and dusty mines referred to above, it will be impossible to get "ground." The floor may be as thin as one inch, and it is broken up by the "faults" with which every coal field is infested. A "fault" is caused by an upheaval, in times long gone by. The strata has been thrown violently upward, with the result that the coal seam has been cut off short, the other portion being sometimes as much as 1,000 yards above or below its fellow. Taking an average, I made out that a probable resistance of the "ground" path was about 300 ohms, perfectly useless for protection in any sense of the term. If, it appeared to me, armor is necessary, and "grounding" necessary, the concentric with uninsulated return offers the best solution. In the course of the discussion, it came out that the saving clause in the departmental rules, by which it was allowable not to armor, had been placed there, owing to the strong representation of some of the colliery managers, and was not intended to be a dead letter. My view has been, from conversations I have had with colliery managers, that the saving clause depended upon the approval of H. M. inspector for carrying out. One manager of a large colliery in Yorkshire, who has had a large experience with electrical apparatus, said that he had been obliged to abandon armor because it led to fires.

The institute paid a visit, among other places, to the British Westinghouse Company's works at Trafford Park, close to Manchester. Points of great interest in connection with colliery work were the apparatus that are being made for some of the large collieries in South Wales which are putting down their own generating stations. In particular, I was struck with a controller for use with three-phase supply for a main and tail plant. This is about the severest trial that an electrical supply system will have about a colliery, except winding. In the "main and tail" system of haulage, the tubs of coal are connected together in a train, and then between two ropes, one of which pulls the full tubs out to the main haulage road, and the other pulls a set of empty tubs back to the "face" again, after the full tubs have been dealt with. The speed is generally very high, and the road which the tubs travel is at all gradients, sometimes with and sometimes against the load. The two ropes wind on two drums, one winding up, while the other lets out, and they have to be reversed every now and then. Also when near the engine, or at the top of the "brow," speed has to be lowered while the tubs are dealt with, the direction of the drums being reversed occasionally. The controller shown at the Westinghouse company's works accomplished all this by the usual handle on the top, the switches working in oil.

There were also some cast-iron boxes arranged for the enclosure of switches for starting motors, for distributing points, etc., the main difficulty of which appeared to me to be finding room for them underground in the positions they would have to occupy.

The Largest Hydroelectric Installation in Southern Asia—I.

Electricity for Industrial Purposes in India.

By A. C. Hobble.

THE first installed plant of the Cauvery power scheme, located in the province of Mysore, southern India, has been in successful operation three years. In December of 1904 was completed the second installation, or extension, of 3,610 kilowatts generator capacity; thus increasing the possible output of the plant to 7,920 kilowatts. Power is transmitted at a pressure of 35,000 volts over duplicate three-phase lines, a distance of ninety-two miles, to the Kolar gold fields, where it is utilized almost entirely in mining operations.

The Cauvery river falls are located near the site of the old Hindu village of Sivasamudram. The Cauvery river is the dividing line between Mysore province and the Madras presidency. At this point a fall of nearly 400 feet is afforded, giving an average calculated horse-power of approximately 12,000 during the dry season of the year and a maximum of over 200,000 horse-power at times during the monsoon or rainy season.

GENERAL MAP OF HYDROELECTRIC DEVELOPMENT AND TRANSMISSION.

THE MODERN VILLAGE OF SIVASAMUDRAM, SHOWING TWIN CHANNELS AND FOREBAY OVERFLOW WEIR.

Work on the first installation of the plant was started near the end of the year 1900, and was completed after many difficulties in June, 1902. The entire success of the scheme is thoroughly emphasized by the fact that the output of the plant has been recently almost doubled, in order to meet the demands of the Kolar gold mining companies for the cheaper power thus afforded. However, provision has been made whereby the city of Bangalore, which has 180,000 inhabitants, is to be supplied with light and power over a separate sixty-mile, 35,000-volt transmission line. This work is now under way and will probably be completed by the time this description is published.

GUNGAN CHUCKI FALLS, CAUVERY RIVER, NEAR SIVASAMUDRAM. HINDU TEMPLE AND SMALL VILLAGE ON THE LEFT.

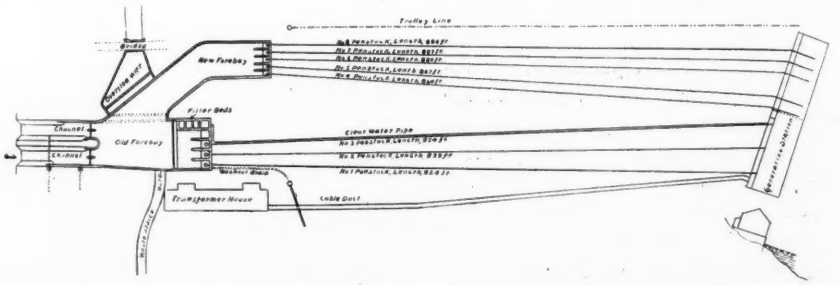
BURR CHUCKI FALLS, EAST BRANCH OF THE CAUVERY RIVER, NEAR SIVASAMUDRAM.

RIVER WORKS, CHANNELS, FOREBAY AND PIPE LINES.

About one-quarter mile above the channel intake, the main river divides into two branches; one flowing east and the other north. Two low level masonry dams divert all of the water in the river during the dry season to the channel intake. The upper dam, located about one-quarter mile

above the intake, and blocking the eastern branch, diverts the water tending to flow that way. The main diverting dam, which is over 2,000 feet long and V-shaped, extends across the northern branch of the river and finally unites with the natural inner rock wall of the intake channel. During high flood the water sometimes attains a depth of six or seven feet over the top of the dam.

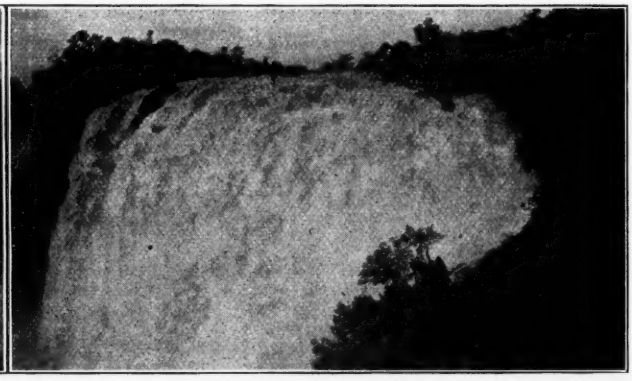
The head gates at channel entrances are about three-quarters of a mile distant above the Cauvery falls, while the power-house is located approximately one mile below the same. The two channels, of which some views are herein given, follow the natural contour of the country and are somewhat more than three miles in length. They are feet on top. The gradient is 1/5,000 for earth work and 3/5,000 in rock cuttings.



General Layout and Relative Location of Forebay, Pipe Lines, Generating Station and Step-Up Transformer Station.

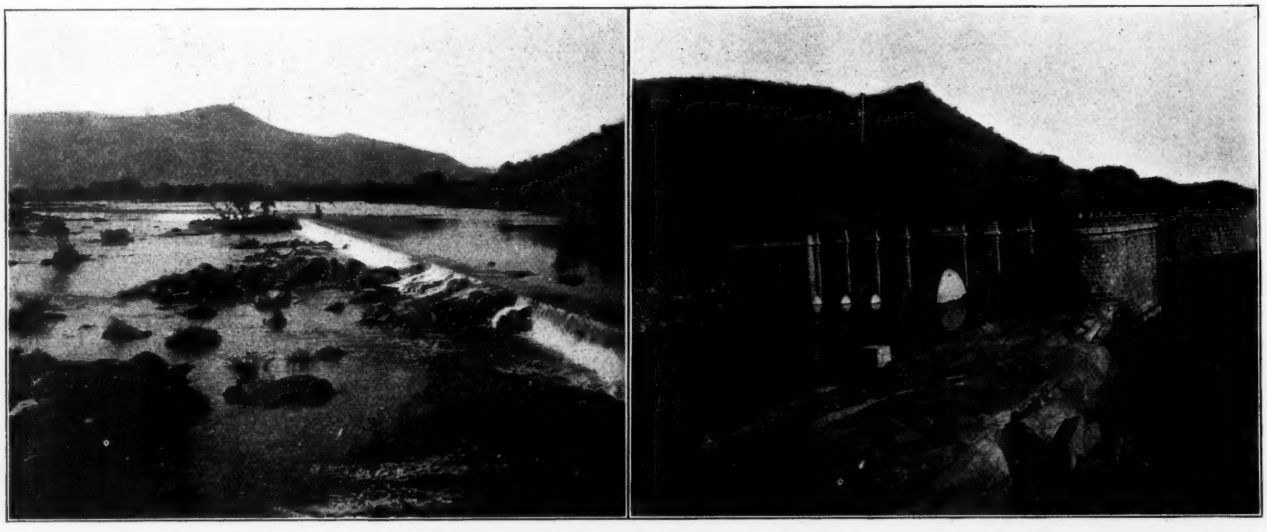
Each channel is supplied with water from the intake channel at the head works through four vents, each measuring four is divided into two sections, though connected together as a whole. One section supplies water to the old penstocks

View of Cauvery Falls During Flood Season, East Branch of River.



A View of the Cauvery Falls at High Flood, North Branch of River.

of trapezoidal section, having stone-pitched sides, with a bed width of eighteen feet in earth cutting and twelve feet and one-half feet by five feet section. The velocity of flow in the channels varies somewhat with the gate opening, but the (three in number), while the other supplies the five new stocks. The water might have been brought to the forebay over a

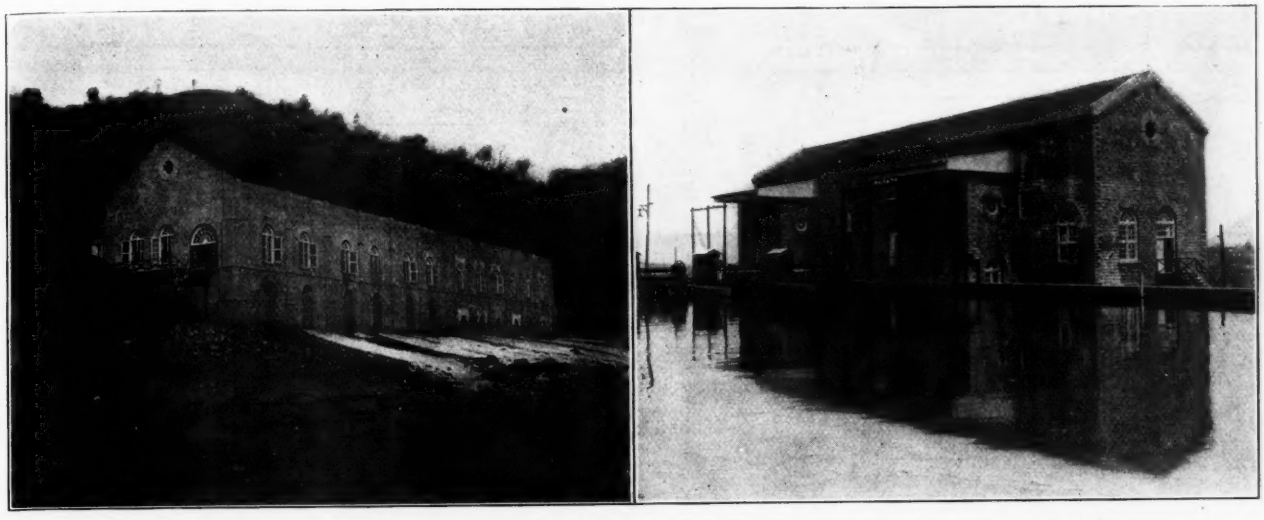


Cauvery River above the Headworks, Showing Main Diverting Masonry Dam and Approach to Intake Channel. The Other View Shows the Intake Channel and Head Gates at Sivasamudram.

in rock cutting. The dividing earth bank partition between the channel measures twenty-six feet width at the base and ten average ranges from two to three feet per second. Scouring sluice vents of four and one-half feet by five feet section are pro- much shorter route if wooden flumes could have safely been used; but local engineers considered such a proposition unsound

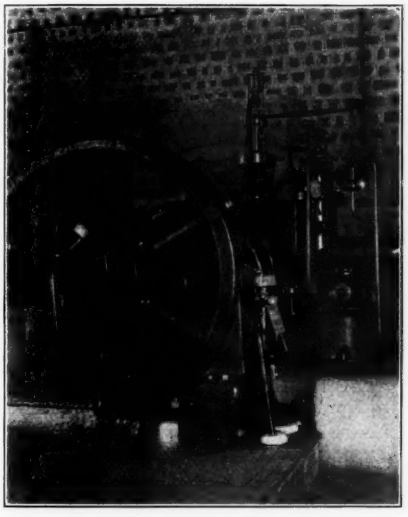
owing to the danger of the flumes being ultimately destroyed by white ants.

the forebay in order to provide for sudden increase of loads. From the two sections of the forebay, steel penstocks convey the water down the steep bluff to the generating station below. The stocks average 900 feet length.

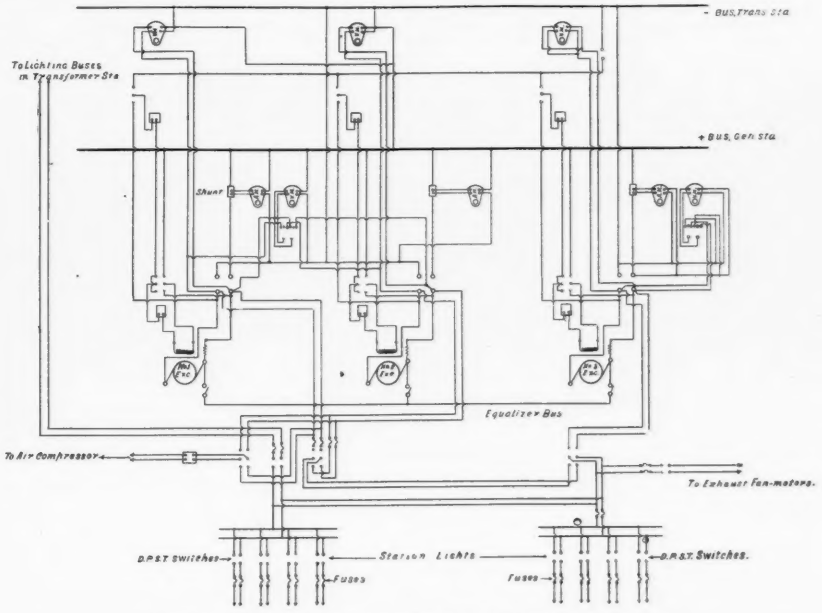


THE GENERATING STATION AT SIVASAMUDRAM, AND THE STEP-UP TRANSFORMER STATION, WITH FOREBAY IN THE FOREGROUND.

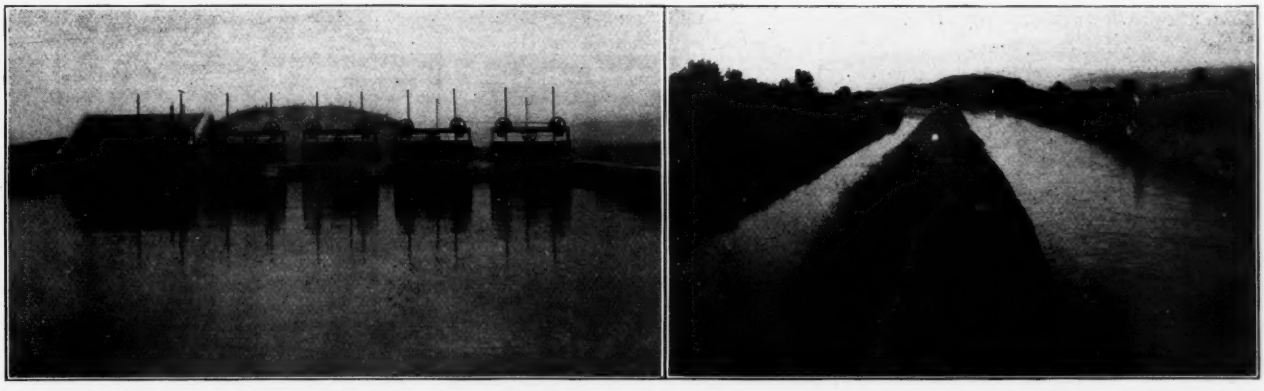
The average depth of water in the forebay is between five and six feet. A surplus amount of water is always allowed to escape over a waste weir at one side of



VIEW OF THE TURBO-EXCITER UNIT IN THE GENERATOR STATION AT SIVASAMUDRAM.



EXCITER WIRING ARRANGEMENTS AND STATION LIGHTING.



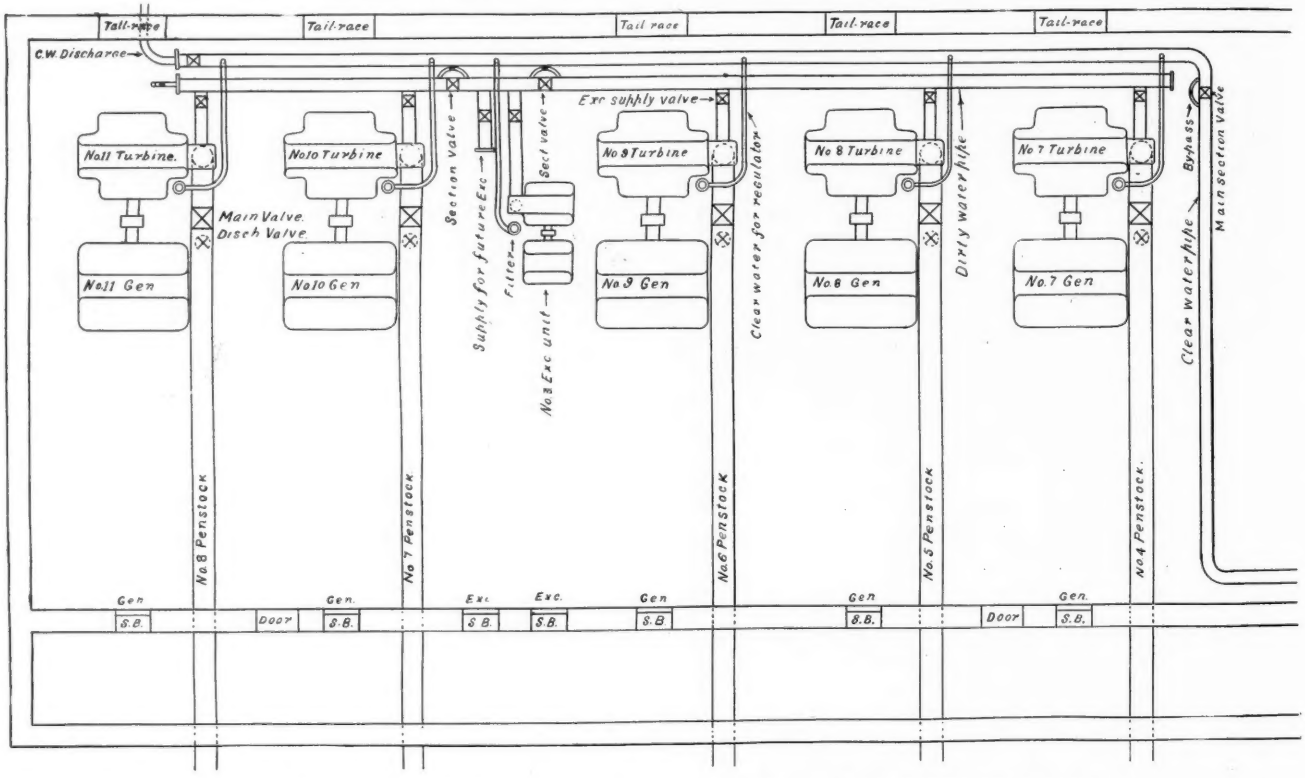
A PORTION OF THE NEW SECTION OF FOREBAY, SHOWING THE VERTICAL SLIDE GATES AT THE ENTRANCE TO THE PENSTOCK CHAMBERS, AT SIVASAMUDRAM, AND A VIEW OF THE TWIN CHANNELS IN THE EARTH CUTTING APPROACHING SIVASAMUDRAM.

The sketch herewith shows the general layout and relative location of forebay,

pipe lines, generating station and step-up transformer station. Each of the five new penstocks supplies one 1,250-brake-horse-

inch to one-half inch in thickness. These and other piping in the power-house were supplied by Mechan & Sons, of Glasgow.

Switchboards are impaneled in the rear wall of the generating room, enabling the operator to switch any individual machine



GENERAL ARRANGEMENT OF TURBO-GENERATING UNITS AND PIPING WITHIN THE STATION.

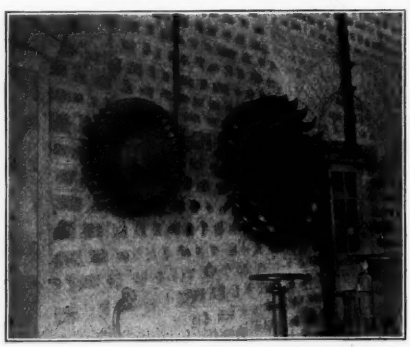
power Escher-Wyss horizontal impulse water-wheel, which is direct-connected through a rigid coupling to a 720-kilowatt General Electric three-phase alternator. The above-mentioned penstocks vary from thirty-six inches to twenty-seven inches in diameter. The old penstocks, three in number and varying in diameter from forty-five inches to thirty-nine inches, after reaching the power-house bifurcate; each branch supplying one 1,250-horse-power turbine. Two expansion joints, adjusted for approximately five inches expansion, are provided in each pipe line.

Entrance of water from forebay to penstock chamber is regulated by a plain vertical iron slide gate controlled by rack and pinions; at the entrance to each penstock is another valve operated by a hand-wheel. A ten-inch main conveys the clear water from the settling-chamber at one side of the old forebay to the generating station below, for the operation of the water-wheel speed regulators. Supports for the penstocks, for over two-thirds their length, are masonry piers placed fifteen feet apart. The average gradient is somewhat more than thirty per cent. All of the penstocks are made of single lap-riveted steel, varying from one-quarter

GENERATING STATION.

The generating station, or power-house proper, is a large building fifty-six feet by 262 feet, outside dimensions. It may be well to state at this point that all of the principal buildings of the Cauvery power scheme are constructed of granite, and another variety of stone, commonly known as "black trap." Most of the material for the masonry work was obtained in the immediate vicinity.

The generating station now contains eleven 1,250-horse-power, 720-kilowatt hydroelectric units and three 125-horse-power, seventy-five-kilowatt, exciter units.



VIEW OF THE ROTATING MEMBERS OF THE 1,250-HORSE-POWER TURBINE AND THE SMALL EXCITER TURBINE.

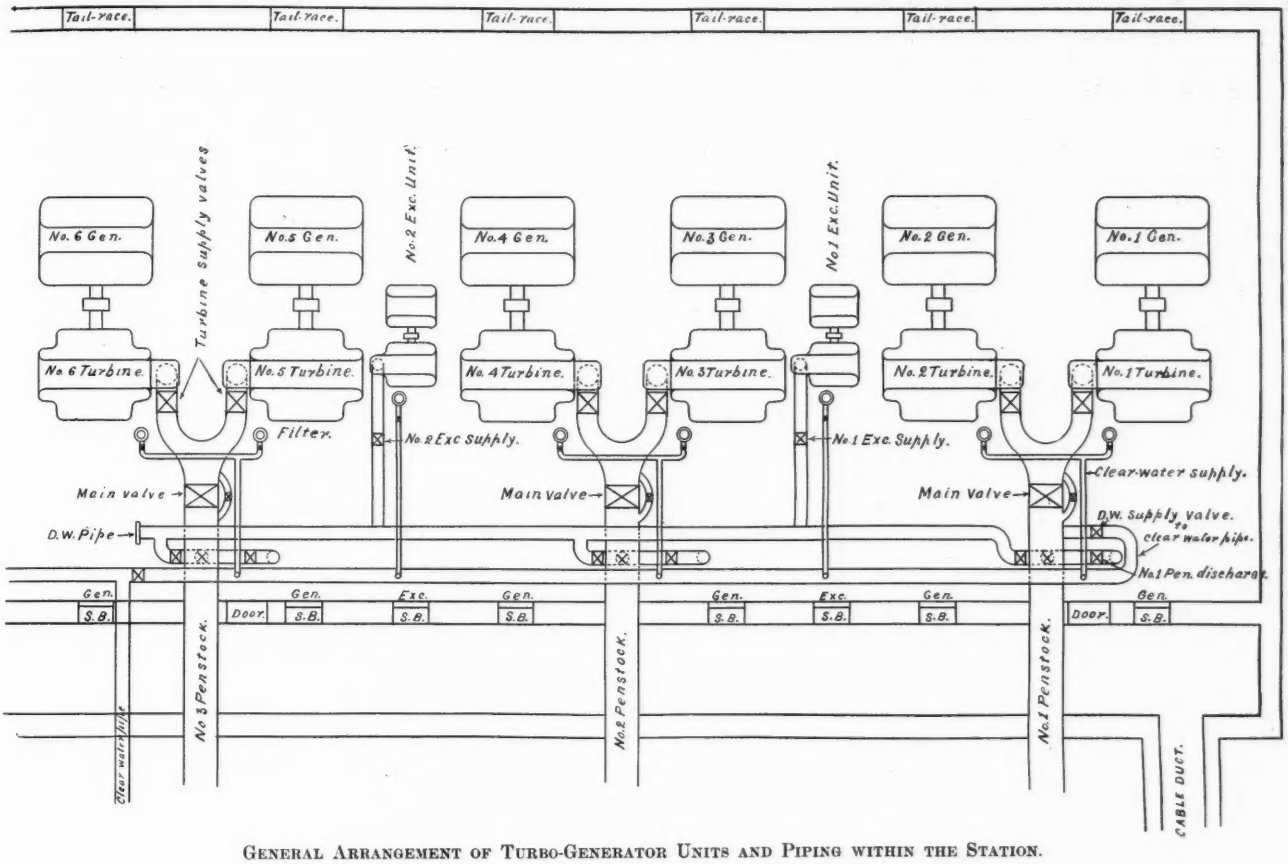
out of circuit should occasion require. Behind the rear wall of the generating room is an eight-foot passageway extending the full length of the station and supplied on one side with stone shelves which support the lead-covered cables leading from the generators and direct-current exciter units to the long stone cable duct which leads up the steep face of the bluff to the transformer station above.

The general layout of generating units and piping within the power-house is shown in the accompanying diagram. The large turbines contain one solid-cast, five-foot impulse wheel having twenty-four buckets on its periphery (see photograph). Each water-wheel has two nozzles which control the supply of water to the wheel proper through three-inch by five-inch rectangular openings. The nozzles are boot-shaped, with the fulcrum, or pivot-pin, at the heel. The height of the toe in the three-inch by five-inch admission vent determines the quantitative supply of water to the wheel.

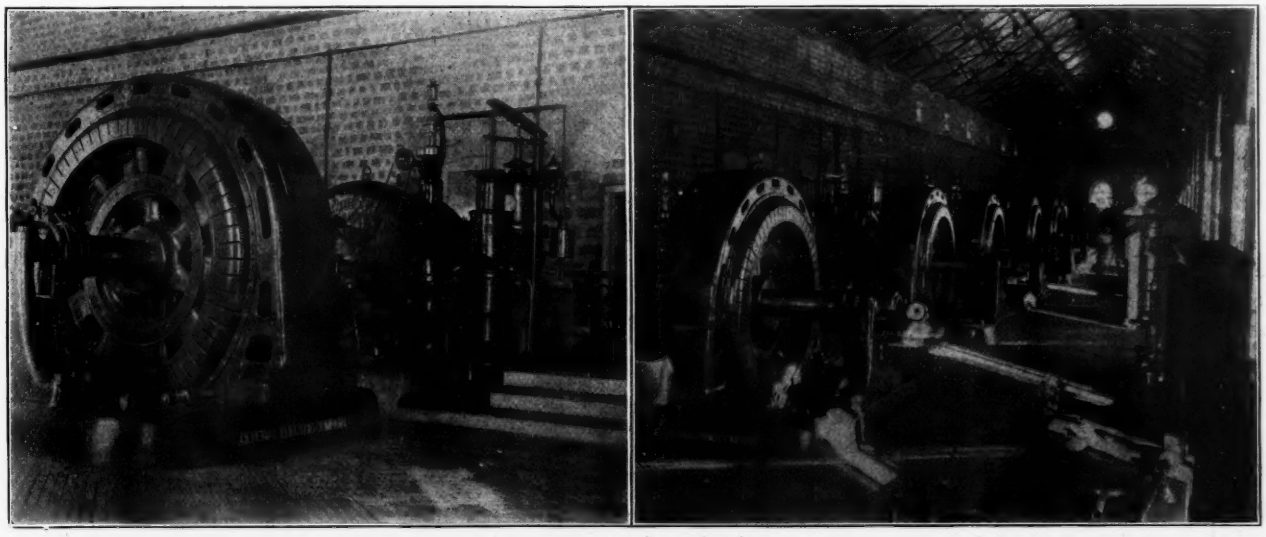
The three small exciter turbines are supplied with water from a ten-inch main which is supplied by a tap from each of the large penstocks. The wheel proper of the small turbines is approximately three

feet in diameter with thirty-six buckets on its periphery.

The most interesting feature connected with the turbines are the hydraulic governors, or speed regulators, which form a part of the wheel, being rigidly connected thereto. These governors are guaranteed by the makers to maintain the water pressure in the pipes constant within five per cent of normal under sudden variations of load. For a ten per cent variation of load only two per cent change in speed is guaranteed and only eight per cent change in speed for fifty per cent variation of load. As before stated, the clear-water pressure is supplied to that part of the governing mechanism which should be the least exposed to wear, hence it is of decided advantage to supply to these parts water which is free of fine sand or other gritty material. However, in case of failure of the clear-water supply, penstock water can immediately be supplied for this purpose through separate taps from the latter to each machine. The action of the hydraulic governor is, briefly, as follows:



GENERAL ARRANGEMENT OF TURBO-GENERATOR UNITS AND PIPING WITHIN THE STATION.



1,250-HORSE-POWER, 720-KILOWATT TURBO-GENERATOR UNIT, SHOWING THE SPEED GOVERNOR. ALSO A GENERAL VIEW OF THE POWER STATION INTERIOR AT SIVASAMUDRAM.

A variation of the station load produces a consequent change in speed of the water-wheel, from the shaft of which the move-

ment is conveyed by means of chain transmission and gearing to the governor fly-balls. The latter, working against a stiff spring, effects a vertical movement of the small governor rod, which in turn controls the movement of a small control valve; the latter is kept constantly in motion by very slight changes of load tending to destroy the equilibrium of water pressure on top and bottom of the valve. So long as the speed remains constant, the water pressure on both ends of the valve is maintained the same. A slight movement up or down of the control valve produces a relatively greater movement of the larger hydraulic piston, to which is attached through connecting rods the two large boot-shaped nozzles. In case of a great change of load, such as that caused by a short-circuit on the transmission lines, resulting in the entire station load being eventually thrown off, a large relief valve quickly opens and allows the surplus or impact water to escape. This valve slowly closes against oil-pressure as the load resumes its normal value. Thus it will be seen that the relief valve takes care of the sudden impact of water when a large amount of power is suddenly switched off in much the same manner as the ordinary overflow stand-pipe for low-pressure heads. A general idea of the size and shape of the speed regulators may be obtained from the accompanying photographs.

The guaranteed efficiency of the large turbines is seventy-five per cent and seventy per cent at full load and one-half load respectively, producing 1,250 brake horse-power at the coupling with thirty-seven cubic feet of water under an effective head of 382½ feet at the turbines. Some ten feet of head were lost on account of having to locate the generating units above the high-flood level of the river. The water during the major portion of the year is quite free from grit, and the steel cups, after three years' service, show an almost imperceptible amount of wear.

The generators are 720-kilowatt, three-phase, 2,200-volt, twenty-five-cycle, 300-revolutions-per-minute machines of the revolving-field type and are Y-connected with neutral not grounded. Since these machines are of the well-known standard General Electric type, no further details are necessary regarding them, suffice it to state that they have given entire satisfaction and no trouble since the plant was first put in operation.

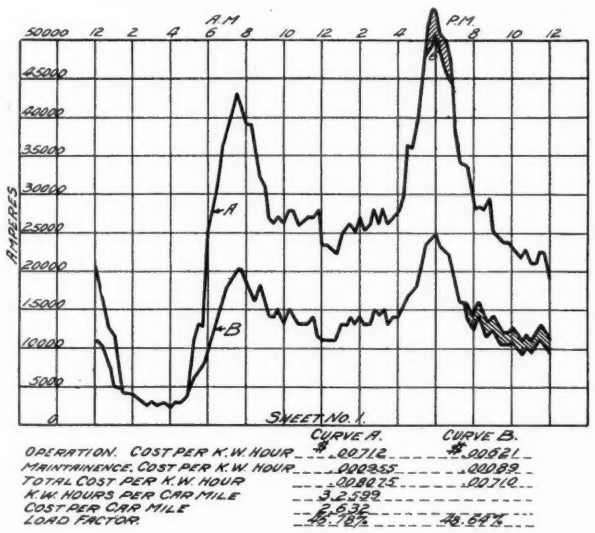
(To be continued.)

THE POWER STATION LOAD-FACTOR AS A FACTOR IN THE COST OF OPERATION.[1]

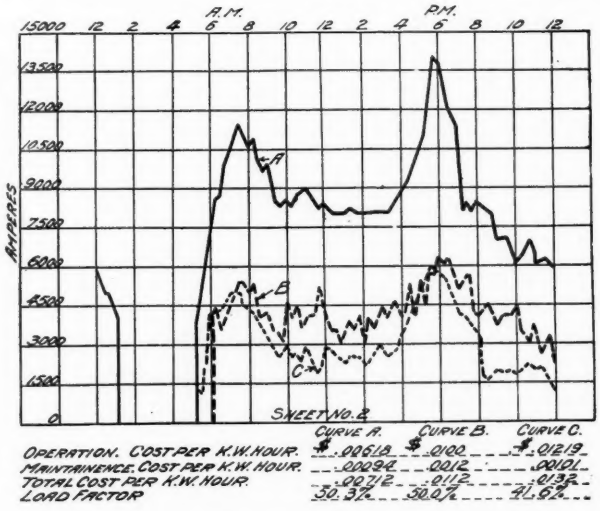
BY LAWRENCE P. CRECELIUS.

The question of keeping proper load charts of the power-station loads has already been given much attention, and its value has long been recognized. The irregularities of a power-station load diagram of a railway system depend entirely upon the nature of the travel on that system.

In urban railway systems the load-curve is double-peaked, having the characteristic morning and evening peaks of city travel when the people go to and from work; the breadth, magnitude and duration of these peaks depending, of course, upon local conditions, such as the size and lay-out of a town, and upon its sociology. In a manufacturing centre the peaks are often remarkably symmetrical, and are little effected by climatic conditions, as the people usually go to work at about the same time in the morning and leave to go home at nearly the same time in the evening. In the larger cities, where it becomes necessary to transport a mixed community consisting of factory employés, merchants, clerks, shoppers, theatre-goers, etc., the peaks lose their symmetry, the morning peak becoming lower and not so sharp as the evening peak. This is accounted for in the fact that in these cities the morning travel generally extends over a period from 6 A. M. to 11 A. M., while in the evening the homeward-bound passengers leave the business districts at about the same



SHEET NO. 1. POWER STATION LOAD-FACTOR.

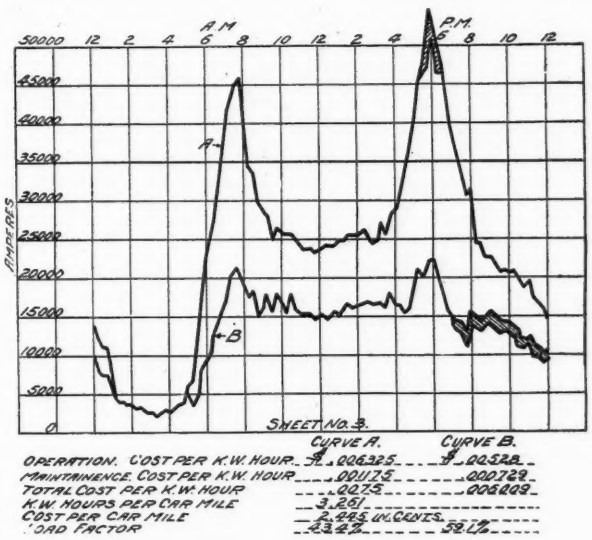


SHEET NO. 2. POWER STATION LOAD-FACTOR.

[1] Abstract of a paper and discussion before the convention of the American Railway Mechanical and Electrical Association, Philadelphia, Pa., September 25-28, 1905.

hour. Here also the condition of the weather and the season of the year become governing factors in the shaping of load-curves.

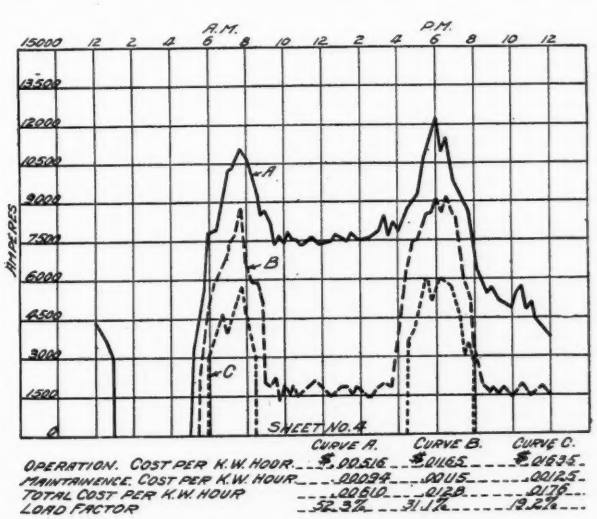
Any method that will tend to smooth



CURVE SHEET NO 3. POWER STATION LOAD-FACTOR.

up the load-curve is indeed worthy of consideration, as an increase in the load-factor means a corresponding decrease in the cost of power per car-mile. This becomes very apparent when we compare the amount of station apparatus which is required to carry the peaks with that which is required to carry the average, and the manifest inefficiency of this arrangement when the load-factor is small. The load-factor is the ratio between the average load and the maximum, and, therefore, represents the ratio between the amount of station apparatus required for the average and that required to do the peaks. Further, since the morning and evening peaks are both three and four hours respectively in duration, we find that from forty-five per cent to sixty per cent of the station apparatus of a system is idle for seventeen hours or more.

Since there are so many causes, depending upon local conditions, which become governing factors in the shaping of a power station-load diagram, and therefore determining the load-factor of a system, it would be very presumptuous on my part to attempt to describe to you a certain fixed method by which the load-factor of a system might be brought up and the advantages derived thereby. Each and every system has its own peculiarities, which have to be met, and which prohibit the application of a general method, hence they must necessarily be dealt with separately. I shall, therefore, confine myself to outlining a method employed by the United Railways Company, of St. Louis, in increasing the load-factors of the main power stations, and showing how the load-factor in this case plays a prominent part in the cost of power per car-mile.



CURVE SHEET NO. 4. POWER STATION LOAD-FACTOR.

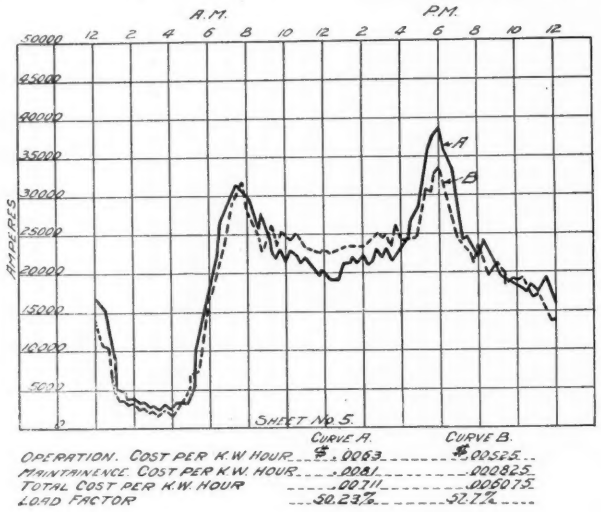
A good many of the larger railway systems are the result of consolidations of the different independent companies in a locality, each having its own power stations, some of which it becomes necessary (for various reasons) to continue in service, and this, in the majority of cases, seldom constitutes the most economical arrangement of power stations for the consolidation. The power-station layout of the United Railways Company, of St. Louis, is of this order. It would be a real treat indeed to have charge of a lay-out where the necessary central station or stations are located at a point where both fuel and water can be conveniently handled, together with enough substations sensibly located, containing storage batteries, to cap off the peaks, etc., as in that event it would be possible to generate power at the lowest price without any apparent effort on the part of the power superintendent.

The United Railways system of St. Louis has in operation four power stations at the time of writing. Two of the larger stations, one of 13,950 kilowatts and one of 7,000 kilowatts capacity, are kept in operation continuously, and constitute the main central stations. The two smaller stations are operated on swing watches on week days, that is, operated during the peak-hours only. Bus wires have been run from the larger stations to both of the smaller ones and there connected through circuit-breakers and double-throw switches to either one of the two feeder buses, with which the smaller stations have been supplied. Installing double-throw switches on both the feeders and bus wires in these stations makes it possible to operate them on one bus to which any number of feeder sections can be connected, and at the same time operate the bus wires, independent of the station on the other bus to which the rest of the feeder sections can be connected. During the rush hours the bus wires are connected to the same bus on which the stations are operated, thereby becoming equalizer wires. The amount of copper in the bus wires is just sufficient to carry the load of the smaller stations during the lighter part of the day, allowing a reasonable drop in potential.

The resulting economy of operation in this case more than justifies the expenditure of a good many dollars and cents in the bus wires, and also the re-

sulting increase in the cost per kilowatt-hour of the power generated under this arrangement in the smaller stations, as may be seen by referring to the load-curves.

In the following load diagrams on sheet No. 1 are shown two curves. The upper curve represents the total load of all the power stations for a period of twenty-four hours. The second curve represents the load on the 13,950 kilowatt station before the installation of the bus wires. Under the curves are shown the cost of operation and maintenance per kilowatt-hour, the cost per car-mile, the kilowatt-hours per car-mile and the load-factor. Curve sheet No. 2 represents the performances of the other stations on the same day. Curve sheets Nos. 3 and 4 are carried out on the same order, and represent the output of each of the stations



CURVE SHEET No. 5. POWER STATION LOAD-FACTOR.

under the new arrangement, after the installation of the bus wires. The summary of the above is as follows: by plotting a curve which is the sum of the load of both the main stations, we can arrive at a curve, the load-factor of which is nearly the correct factor to work by, as obviously the effect of the load-factors of the smaller stations will have little bearing upon the total cost of operation as compared with that of the larger stations. Nevertheless the shutting down of these stations during the lighter part of the day, thus operating them at an absolute disregard toward economy, does influence the load-factor of the main station curves very materially, and ultimately effecting a saving. This is clearly shown by the curves on sheet No. 5. Curve sheet No. 5 represents the same curves of the two main stations when working under both conditions. Curve "A" represents the load of the main stations for the same day on which all four stations were in operation all day. Curve "B" represents the load of the same stations when taking the load of the smaller stations during the lighter part of the day. Thus it is found that in bringing up the load-factor of the sum curves of the main stations from 50.23 per cent in the first case to 57.7 per cent in the second, that a saving of 0.000575 of a cent per kilowatt-hour has been made on the total power cost. And on a basis of 310,000 kilowatt-hours per day, which is about the average output of the stations of this system during the summer months, this would represent a saving of $178 per day when operating under these conditions. All of the above figures, giving the cost of operation and maintenance per kilowatt-hour, were taken from a report received monthly from the auditing department, while the curves were plotted from readings taken daily, therefore it is possible that the cost of power per kilowatt-hour for the specific days shown on the curve sheets may have been a trifle more or less than given.

The curve sheets show the use of a storage battery to level the evening peak. The charge and discharge of the battery are shown by shaded areas above and below the load-line. It has been found that since the installation of the battery, which is located in the business district of the city where the traffic is very congested, the service has been increased to a marked degree during the rush hours. Also a large reduction in the amount of copper required to handle the sections located in this district from the four stations has been effected. This, together with the fact that a battery can always be called upon in cases of emergency to take hold of the load, points to the advantages to be derived in using storage batteries to smooth up the load-curve when conditions warrant their use.

There is still a tendency among power men to regard batteries with suspicion and distrust, owing partly to the enormous cost of a complete battery installation, and partly to the rapid depreciation of a battery when overloaded. Nevertheless, the use of storage batteries abroad, with their attendant economical results by leveling load-curves, has gradually led to the adoption of them here, until now we find that in every modern installation they form an integral part of the power equipment.

DISCUSSION.

Mr. Charles Hewitt stated that in Philadelphia they had six storage batteries, five of them being located in substations and used for facilitating the distribution of the load and for steadying the load. The sixth battery is connected directly with one of the stations; he could not give the load-factor in percentage, but thought it was about seventy to seventy-five per cent, that is the average of the various stations. They had a practice in Philadelphia of maintaining a full load on every engine throughout the day by means of tie lines, but they transpose the load from one station to another to accomplish such results. In that way, no matter what time of day it may be or what the load may be the engines which are running are running at practically their most economical load and the storage batteries no doubt assist very greatly in accomplishing that. They notice the effect of the batteries very strongly in the operation of the station. After nine years' experience with the batteries they have not reduced the cost per kilowatt-hour, but they have materially assisted in maintaining a good load-factor and in enabling them to transpose the load from one station to another. In regard to the load-factor of seventy or seventy-five per cent, he referred to the same kind of load-factor Mr. Crecelius referred to; that is, the relation between the maximum load and the average load. Two terms had been given this load-factor. Some authors speak of the load-factor as the relation between the possible output and the average output. The load-factor he was speaking about was the relation between the minimum and the average. It did not refer to any special time of the day, but throughout the twenty-four hours.

Mr. Crecelius, in answer to a question regarding the cost of coal, said it was

a variable quantity. In some cases they burned pretty good lump coal; $1.25 to $1.30 per ton. This runs from 1,200 to 1,300 British thermal units in its calorific value. In their big stations they burn the coarsest grade of slack they can get hold of. Its calorific value does not go much over 900 British thermal units. The ash is pretty high in fixed carbon, but they get the coal at about seventy-eight cents per ton. Rather than endeavor to secure economical apparatus to get the maximum heat value, and thus tie up money, they can afford to throw the refuse of the coal away.

Mr. Paul Winsor remarked that in studying the subject of bettering the load-factor you get into two or three things, one of which they had done in Boston, the tying of stations together. They tied the stations by copper directly and feed certain sections from two stations. They can shift the load from one station to a section that may be equidistant from two stations, either to one station or the other, and in that way keep the machines at one station fully loaded and be able to shut down machines at the other station. If they tied it by copper together from one bus-bar to the other they got the same result as far as loading the machines was concerned, but introduced heavy losses because they got losses of current jumping from one station to another station several miles apart, and also low voltage at the second station, yet the result on the power-house, without a reduction of cost per kilowatt-hour, would be the same in both cases. He believed that batteries would introduce losses which would fully tend to offset the benefit derived in the power-house and that, although they could cut down the number of units in the station by using storage batteries, it would be better to spend the money for new apparatus in the power-house where it could be used twenty-four hours a day than to put it in storage batteries where it could only be used for a few hours a day.

Clocks Controlled by Wireless Telegraphy.

A consular report states that Dr. Max Reithoffer, of the Vienna Technical High School, has been cooperating with a local watchmaker in developing a system of controlling clocks by means of wireless telegraphy. A plan has been submitted to the common council, which provides for furnishing chronometers and electrical apparatus free to the city, provided the city furnish the necessary power and the wire connections. The common council has appropriated $600 for making the experiments.

MULTIPLE-UNIT SYSTEMS OF TRAIN CONTROL.[1]

BY HUGH HAZELTON.

The first operative system of multiple control was installed on the South Side Elevated Railway, in Chicago, and put into operation in 1898. The Boston Elevated Railway also adopted the Sprague control, of a somewhat modified type, and began the operation of its cars in 1901. The General Electric Company and the Westinghouse Electric and Manufacturing Company also developed multiple control apparatus, and sample equipments of the three types were put into competitive operation on the Boston Elevated and on the Brooklyn Elevated Railway.

There are at present on the market two types of multiple control apparatus, known respectively as the Sprague-General Electric control and the Westinghouse Electric pneumatic control. By the combination of the Sprague and General Electric companies, the best features of the apparatus of both systems are brought together. The "contactors" of the General Electric Company have proved greatly superior to the drum-type of controller, and the Sprague-General Electric system now has the General Electric type of contactor switch and reverser, and the Sprague current-limit relay and master controller.

The Westinghouse company has also adopted in its present electropneumatic control a "unit switch," or contactor, in place of the original drum controller, and this switch is operated by means of an air cylinder with electrically controlled valves. It is worthy of note that while the design of the mechanism has been radically changed and materially improved, the fundamental principles of operation, defined by Mr. Sprague and incorporated in his original apparatus, have finally been adopted almost unchanged by all manufacturers of control apparatus to-day. As a practical uniformity of results is obtained by the control apparatus of both systems now on the market, some attention will be given to the advantages common to both, and a comparison of the more important features of difference in the design of the apparatus supplied by each company.

Contactors—In both systems independent switches, or contactors, are now used for closing and opening the main motor circuits. With these independent switches large current values may be handled with greater safety and certainty than was possible with the drum-type of controller, for a wider air-gap and stronger magnetic blow-out are provided, and the contacts of the independent switches open more quickly than was possible with the revolving drum controller.

In the General Electric contactor the contact fingers are closed and opened by a solenoid wound for line potential, which is operative between the limits of 300 and 750 volts. The advantages claimed for this design are simplicity and low cost of maintenance, by reason of the small number of working parts.

The Westinghouse contactor consists of a similar switch and blow-out coil, but an air cylinder is provided for opening and closing the contact fingers of the switch, and electropneumatic valves for controlling the admission of air to the cylinder. The valve magnets are energized by current at fourteen volts potential, supplied by a duplicate equipment of storage batteries. In the present design the Westinghouse contactor provides a wider air-gap between the contact fingers when open, and greater pressure to the contacts when they are closed, than in the General Electric design. The amount of air-gap and pressure necessary for satisfactory operation is, however, capable of definite determination, and with either solenoid or air-cylinder operation results equally satisfactory may be secured. The rapidity of closing the contacts is less with air operation, and the wear resulting from the hammer-blow correspondingly less. While the use of fourteen volts potential for the operating circuits makes it necessary to install and maintain duplicate storage batteries on each motor-car, there are compensating advantages, for the operation of the contactors is made independent of line voltage and of interruptions of current on the forward car. Another advantage of the independent operating circuit is the possibility of stopping the train, even in the unusual event of simultaneous failure of brakes and power supply, by reversing the master controller handle to multiple so that the motors are made to act as generators.

Current-Limiting Relay—The current-limiting relay, common to both systems, consists of a solenoid placed on each motor-car through which the current of one motor passes. The armature of this solenoid is attached to a contact disc which opens and closes the operating circuit for the main contactors. The operation of the current-limiting relay may be described as

[1] Abstract of a paper and discussion before the convention of the American Railway Mechanical and Electrical Association, Philadelphia, Pa., September 25-28, 1905.

follows: in starting the train the motorman usually turns his master controller to the full multiple position. The current is first completed to the contactors that connect the motors in series with all resistance in circuit. This connection is maintained, and the armature of the current-limiting relay is drawn up until the counter-electromotive force, due to the increasing speed of the motor armatures, causes the current in the motor-circuit to drop to a value which no longer holds up the armature of the current-limiting relay. This armature then drops and makes connection to the operating circuit of the next resistance unit. The contactors are thus interrupted in their progression at each successive step, so that a nearly constant amount of current is allowed to the motors during the period of acceleration until the motors are in full multiple without resistance. The current-limiting relay is now recognized as an important, if not necessary, feature of multiple control systems, and its use provides operating advantages which are not obtained in any system of hand control. With the hand controller the motorman starts his car as quickly or as slowly as his judgment or caprice may dictate, and the slipping of the driving wheels is the only limitation to the amount of current imposed upon the motors in starting. For heavy electric service it is specially desirable that the current used in starting trains shall be kept within certain well-defined limits. Consideration of speed requirements and economical use of power fix the minimum rate of acceleration and the corresponding minimum starting current, while the maximum allowable acceleration and starting current is defined by the following considerations:

(1) Excessive starting current results in violently fluctuating loads at the power-house, and in order to meet these demands the power equipment must be increased in output and the line equipment in carrying capacity. On interurban roads, where the number of trains on the line is small, the fluctuations due to heavy starting currents is especially objectionable.

(2) Excessive current applied to the motors results in destructive mechanical strains which materially increase the maintenance charges on gears, pinions, armature shafts and bearings. On an elevated road which has recently discarded hand control for multiple control with automatic current input, the number of motors laid up in the shop for repairs is now only four, where formerly it was fourteen. With the current-limit relay on each motor-car, each motor does its share of the work, irrespective of possible differences in wheel diameter or variation in the electrical characteristics of the different motors.

Master Controller—The provision made in the master controller, of both systems of control, for opening the main circuit and applying the air-brakes whenever the motorman releases the controller handle, is considered a valuable safety feature, and its application is so simple as to well warrant its use. The master controller on both systems is very small and compact, as it handles only the small currents of the operating wires. In the Sprague-General Electric system the control circuits require not over two and one-half amperes at 600 volts, with two 125-horse-power motors, and in the Westinghouse system not over ten amperes at fourteen volts for a ten-car train.

Line Relay—In both systems a potential or line relay is provided which opens the main circuit whenever the supply of current from the line is interrupted. When the current is again restored to the line the contactors are closed through successive resistance steps before returning to their former positions. This device obviates the shock which would otherwise occur in passing over road crossings or turnouts where the continuity of the third rail is broken.

Bus Line—In connection with multiple systems of control, it is often advisable to install a bus-line cable throughout the train connecting the several contact shoes, so that in case the shoes of one car are not in contact with the third rail, the motors of this car may receive current through the bus line from the other cars. The bus line greatly facilitates operation where it is necessary to interrupt the continuity of the third rail at street crossings or yards, and at such points a continuous supply of current for motors and for car-lighting is—thereby maintained. The bus line also serves to eliminate motor flash-overs, which sometimes occur when the cars are running at high speed, and the supply of current is suddenly interrupted and restored, as is the case when the contact shoes on one car momentarily lose contact by striking a high joint or an approach incline. In the case of snow or sleet on the third rail, the bus line serves to distribute current to all the cars in the train from any car which may secure contact with the third rail.

Circuit-Breakers and Fuses—For the protection of circuits against excessive current, circuit-breakers and fuses are used in connection with multiple control apparatus. Fuses are usually placed in the circuit from each contact shoe, and a common form of shoe fuse consists of two copper wires, about No. 9 B. & S., connected in multiple with suitable terminals and placed on the wood beam that supports the contact shoe. Some of the large roads are using enclosed fuses of 400 amperes continuous-carrying capacity in place of the copper wire fuses. For protecting the main motor-circuit some roads are using fuses and some circuit-breakers. The type of fuse most widely used for the purpose consists of a copper ribbon ten mils in thickness and one and one-fourth inches wide, placed in a fire-proof box with magnetic blow-out. A hole one-half inch in diameter is made at the centre of the ribbon, so that the fuse will begin to melt at the centre. A copper ribbon of this size will carry 400 amperes continuously. For larger capacity the number of copper ribbons is increased. These fuses will open an overload or short-circuit with entire safety, and the cost of renewals is small. They do not open a short-circuit with as little noise and flash as the enclosed type of fuse however. When a circuit-breaker is placed in the main motor-circuit it is arranged with a tripping device, placed in the motorman's cab, and in some cases the circuit-breaker may be reset from the cab also. There is some doubt of the advisability of resetting the circuit-breaker until an examination of the cause of its opening is made, and the trouble remedied.

In equipping cars with multiple control the practice of placing all the apparatus under the car has now become standard. The main motor-circuits are all kept below the car, and the wiring is done in iron conduit pipes, and the bottom of the car is thoroughly protected by fireproof material. These precautions have greatly reduced the risk of fire, and on one of the elevated roads in Chicago which has recently replaced its original hand control by multiple control apparatus, the underwriters have voluntarily reduced the fire insurance rate. The reduced fire risk is also given as the controlling reason for the installation of multiple control apparatus on single motor-cars on one of the street railway lines recently opened in Boston.

Before leaving the subject of multiple control, a word should be said concerning the reliability of the apparatus in service—for this is the final measure of merit.

During the first years of its introduction, the most serious obstacle against the adoption of multiple control was the ap-

parent complication of the system, which suggested a doubt as to whether it could ever be operated with as few failures as the simpler apparatus of hand control. The experimental stage is now past, however, and in the more modern types of multiple control it is safe to say that the apparatus is fully as reliable in operation as hand control, and it has the ability of handling much larger current values. On the Manhattan Elevated Railway, in New York, where there are over 800 motor cars in daily service, the number of delays to service, chargeable to failure of control apparatus, averages only about five per month. It is the practice to inspect the control apparatus on this road once every three days, and except for occasional cleaning, little work is necessary.

In conclusion, the writer would express the hope that this paper may serve to emphasize the merits of the multiple control system for many interurban and street railway lines where the limitations of hand control have stood in the way of the best service and most complete development of the property. The ability to run cars in trains of any desired length, without reduction in speed, and without overloading the motors; the advantage of limiting the current during acceleration to a predetermined value, and the decreased fire risk by placing the control apparatus under the car, are features of the multiple control system which warrant the attention of all progressive railway men.

DISCUSSION.

Mr. Paul Winsor stated that they had put on forty surface cars with multiple control, but that was done temporarily because they found the platform controller was not large enough to handle the cars. They had many accidents with platform controllers and a good many claims on account of them. They felt that the currents were too heavy to be handled on the platform of the car.

Mr. E. W. Olds remarked that they had realized for a number of years it was necessary to do something to take care of the large flow of electricity with their four-motor equipments. The accidents due to short-circuits and the failure of controllers to break the arc was a serious matter, and he believed the controller should be removed from the front platform. To do that was the question. His company was having constructed at this time fifty equipments which would to a certain extent remove the fireworks from the front platform. They were planning to use one of the K-types of controllers with two contactors in the circuit, the idea being that the controller contacts will be made before the closing of the main contactor system; it would be the reverse from the opening of the arc. By this method the main circuit is opened and closed underneath the car so that in case of short-circuit it will not be at the controller. He had found upon investigation and in their own practice that most of the so-called controller accidents and blow-ups are not caused by the failure of the controller but by some short-circuits in the other apparatus, and the flow of current being so great that the ordinary cylinder type will not break the arc and the result is a burned-out controller. They had arranged the wiring of this controller so that one side of the armature will be always positive, doing the reversing in the fields. By this method they are able to protect each motor with its own individual fuse, so that should a short-circuit occur in the motor or in the wiring the individual fuse of that motor would blow, cutting out the motor.

Mr. W. D. Wright thought that they were all agreed that the removal of the controller from the front platform was a desirable step. Last summer his road had considerable controller trouble on the open cars. This year there had not been as much, and as an experiment they had two open cars running on which the controllers had been swung around outside the dash. That gave more clearance on the platform. The motorman handled the apparatus in the new position about as well as in the old position. Putting the controller outside the dash necessitates building the bumpers out a little. He asked Mr. Olds if the fuses he spoke of are in a position where they can be readily ascertained if they blow, and what type of fuse he used.

Mr. Olds remarked that regarding the fuses they had decided to adopt the enclosed fuse which is on the no-arc principle, and as far as locating the fuses is concerned, they are placed underneath the centre of the car in a box by themselves and he anticipated very little trouble in locating a blown fuse. They had met with some complications arising from not being able to locate some blown fuse, that was not serious and can easily be overcome. The principal thing, and one which he considered of vital importance, was that the companies make the cars safe for the public and do away with the explosions in controllers. The fuses they are using are of sufficient capacity so that they will not blow on an ordinary overload; it would take a short-circuit to blow them and the circuit-breaker or main fuse will take care of the overload.

Mr. Edward Taylor, of Brooklyn, stated that they had built and were operating in Brooklyn a multiple-unit system of control. The main thing in designing this controller was to make it simple and yet effective; to make it so simple that the ordinary electricians and shop-foremen could understand it and maintain it. No fine machine parts were used such as are required in a pneumatic system. The main principle of the apparatus was a simple solenoid which is operated by a rapid switch which notched the controller up a step at a time. The rapidity of this was effected by a throttling device or limit set at any predetermined point. In connection with the controller the circuit-breaker was operated automatically as was also the air-brake equipment, that making an automatic air out of the straight-air system. The point was borne in mind in designing this to have the normal position at safety, so that in case any connections were broken, or any of the circuits interrupted, the apparatus would go to the stop-position. All parts were released by springs by gravity, not depending on electric circuits. For instance, if the car was running along with the controller up and the brakes off, and the pole came off, the controller would be running off, circuit-breaker dropped out, and brakes applied. This feature would save, particularly, a great deal of controller wiring and suspension troubles. An original device was also used in connection with the operation of the magnets. Heavy currents were used at the start to ensure a strong pull on the magnets. Later, when the magnets were in operation, high resistance was automatically put in circuit which reduced the running current to as low as one-tenth of an ampere on the entire apparatus. A special feature of a controller of this sort was that cars could be run singly in the city or congested districts and operated together over the suburban lines. By placing a control apparatus on the trailers it would make it possible to operate them from the trailer or motor, thereby not necessitating changing the trailer around the motor at the end of the line. The experimental apparatus had cost considerable to construct, nevertheless they estimate if they were building a large quantity this controller could be built with the money that could be realized by taking off the other apparatus and the lesser amount of wiring which would be used.

Spokane & Inland Railway.

A contract has been closed with the Spokane & Inland Railway Company by the Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa., for the equipment of an electric road, the present terminals of which will be Spokane, Wash., and Moscow, Ida., 146 miles apart. The roadway is completed from Spokane to Waverly, a distance of thirty-four miles, and operation will be begun on this as soon as possible. The road is a home enterprise, the stock being held entirely by men living in the district through which the line passes—business men, professional men and farmers. The directors of the company are J. P. Graves, president; F. A. Blackwell, vice-president; F. Lewis Clark, John Twohy and Alfred Coolidge, all men of wealth who have been so long identified with enterprises of magnitude that their names ensure the success of any undertaking with which they associate them.

In selecting the equipment for this road both the direct-current and the single-phase systems were considered, but after careful comparison the single-phase alternating-current system was adopted. Not only did the estimates show a large saving in initial investments and in annual operating expenses in favor of the single-phase system, but a form of heavy traction is made possible which would be practically unfeasible with the alternating-current, direct-current equipment. Besides the passenger traffic, the company is preparing to do a heavy freight business and also to carry mail and express.

Power for the operation of the road will be purchased from the Washington Water Power Company, which will supply three-phase current at 4,000 volts, 7,200 alternations, to a frequency-changing station approximately one and one-half miles from the generating station. Seven 750-kilowatt oil-insulated water-cooled transformers will step down the voltage from 4,000 to 2,000 volts, the potential for which the induction motors of the frequency-changing sets are wound. There will be four of these motor-generators or frequency changers of 1,000-kilowatt capacity each at normal rating. Each consists of a 1,000-horse-power, three-phase, 2,000-volt, sixty-cycle induction motor, a 1,000-kilowatt single-phase, 2,200-volt, twenty-five-cycle revolving field alternator, and a 750-horse-power, 550-volt direct-current generator which is to float on the storage battery, acting alternately as a motor and generator. The three machines will be mounted on a single bed-plate with seven bearings. Exciting current for the alternators will be supplied by three sets, each consisting of a seventy-five-horse-power, three-phase, 2,000-volt induction motor and a fifty-kilowatt direct-current generator.

Nine 675-kilowatt, oil-insulated, water-cooled transformers will step up the voltage from 2,200 to 45,000 volts, at which pressure it will be transmitted to the fifteen static-transformer substations, each containing two 375-kilowatt, 45,000-6,600-volt, oil-insulated, self-cooling transformers. A twenty-three-panel switchboard, electrically operated, automatic oil circuit-breakers, and protective apparatus complete the equipment of the frequency-changing station. Low-equivalent lightning arresters and choke coils are provided for both primary and secondary circuits in all substations.

The transmission lines will consist of two No. 2 copper wires, and the trolley will be of the standard catenary construction, using a No. 000 wire and carrying current at 6,600 volts.

Each passenger car will be equipped with four 100-horse-power motors, capable of maintaining a schedule speed of thirty-five to forty miles an hour. In the freight service four 150-horse-power motors will be used on each car. For the heavy freight service double locomotives weighing approximately seventy to eighty tons will be used, each consisting of two parts and each part a complete thirty-five to forty-ton locomotive. Two or more of these locomotives may be coupled together and operated from the front cab as a single unit. The motor cars and locomotives will all be operated by the Westinghouse multiple-unit control system. The motors will operate under three different conditions—6,600 volts alternating current in the interurban districts, 700 volts alternating current in the smaller towns and 575 volts direct current in the city of Spokane.

Pure Magnesia a Non-Conductor at High Temperatures.

In the account of the Bethlehem meeting of the American Electrochemical Society, published in the ELECTRICAL REVIEW, September 30, Dr. E. F. Roeber is reported, during the discussion of his paper on "The Thermodynamics of the Incandescent Lamp," as saying: "magnesium heated to a high temperature does not conduct." This clause should read "magnesia heated, etc.," the point being the fact that the pure oxide of magnesium is a non-conductor of electricity at high temperatures.

De Forest European Patents.

The De Forest European wireless telegraph patents have been sold to a syndicate of prominent Englishmen. Lord Armstrong, head of the shipbuilding concern of Armstrong & Whitworth, is the chairman of the new company. The patents of Nevil Maskelyne are included in the purchase. The capitalization of the company is £120,000, and the transaction was consummated by Mr. Franck Z. Maguire, of New York and London. Mr. Maguire formerly represented Mr. Edison abroad, and has devoted most of his time for several years past to the development of American enterprises in foreign countries.

Wireless Telegraphy in Germany.

A wireless telegraph service has been established between Dresden and Berlin by the Gesellschaft für Drahtlose Telegraphie. The distance is 114 miles, and the antenna consists of 100 wires in an inverted pyramid. This system of wires is supported by four masts 230 feet high. Power is drawn from a fifteen-kilowatt alternator, the voltage being stepped up to 50,000. This system is able to send messages to Mairenleuchte, 171 miles distant, and to Karlskrona, Sweden, 280 miles distant. It is said that during the night disturbances are received from the Marconi station at Poldhu, which is about 760 miles away.

Kansas Light and Street Railway Meeting.

The eighth annual meeting of the Kansas Gas, Water, Electric Light and Street Railway Association was held in Kansas City, Kan., on October 13 and 14.

The following papers were announced: "The Tantalum Lamp," by Professor B. F. Eyer, of Kansas State Agricultural College; "Producer Gas," by R. M. Sutton, of Wichita; "The High Efficiency of High Candle-Power Lamps," by J. F. Schaefer, of Kansas City, Mo.; "Need of Sewage-Disposal Plants in Kansas," by R. E. McDonnell, of Kansas City, Mo.; "Cooperation in Management of Gas, Water, Electric Light and Street Railway Companies," by C. R. Maunsell, of Topeka; "Public Utilities and Municipalities," by Professor E. H. S. Bailey, of University of Kansas; "Purification," by E. S. Springer, of Leavenworth; "Relative Heat-Producing Values of Natural Gas, Oil and Coal," by Professor Erasmus Haworth, of University of Kansas.

THE SERIES-PARALLEL RAILWAY CONTROLLER.[1]

BY W. A. PEARSON.

When the first electric railways were put into operation one small motor was considered sufficient to propel a car.

On some of these early equipments in which shunt motors were used, the brushes were designed to be moved around the commutator for the purpose of reversing the direction of rotation, it being considered impossible to provide the same neutral commutating points for both directions.

In developing the series motor it was found that common neutral points for both directions of rotation could be produced, permitting the use of a double-pole, double-throw switch for reversing the connections of the armature leads.

The simplest way to start and control the speed of the single motor was to use a dead resistance in series with it. This method, which was adopted, has been successfully used for single motor equipments since the earliest days of the art.

To meet the increased requirements of heavier cars and higher speeds, a second motor was added to the equipment. As the rheostatic control had proved sufficiently satisfactory for one motor equipment, it was also considered suitable for two motors permanently connected in parallel. Consequently a heavier rheostat was used with two motors connected in this manner.

At first a reversing switch similar to that used for a single motor was employed, the armature leads from the two motors being connected in parallel. This connection was soon found to be impracticable owing to the unbalancing of the load on the two motors, and necessitated the use of separate reversing switches.

In order to obtain an efficient running speed at somewhat less than the full speed of the motor, several methods of varying the field strength were tried with different degrees of success. Some motors were provided with field taps, or "loops," the full field being intended for use in starting and in ascending heavy grades.

The field strength was weakened by cutting out a portion of the winding by means of the tap, thereby allowing more current to pass through the armature, increasing accordingly the speed of the motor. Another method consisted in connecting sections of the field coils, first in series and then in parallel to produce different field strengths. These two methods were used for a few years, and finally abandoned owing to troubles resulting from the burning out of field coils. In the next field variation method that was used, a resistance was placed in shunt around the fields of each motor, thereby accomplishing the same result but in a somewhat different manner. This also led to complications, as motors were operated under

FIG. 1.—SERIES-PARALLEL RAILWAY CONTROLLER.

such varying conditions. In some cases the full field point was used excessively by the motorman, the coils becoming overheated, and in other cases the shunt point was used too much on heavy grades, resulting in armature and commutator troubles.

Field variation for obtaining speed control was abandoned by the manufacturers of railway motors about nine years ago, and since that time but two speeds have been provided without series resistance in controllers supplied with two motor equipments.

About fourteen years ago the attention

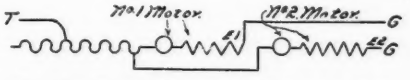


FIG. 2.—SERIES-PARALLEL RAILWAY CONTROLLER.

and energies of manufacturers of railway apparatus were applied to the development of a control for two motors which, when starting or running slowly, would waste less power than the rheostat and would permit running efficiently at half speed.

The method which seemed to promise the best result was to start the motors in series, and after they had reached their full speed for this position, re-connect them in parallel. Many different experimental controllers were constructed in the

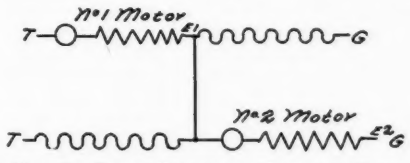


FIG. 3.—SERIES-PARALLEL RAILWAY CONTROLLER.

attempt to produce a satisfactory piece of apparatus.

Nearly all original electrical apparatus was crude as viewed from our present standpoint, to which view these early series-parallel controllers formed no exception.

One of the forms was fan-shaped with a stationary slate board to which were secured the motor, resistance and other contacts, with a movable arm, pivoted at its lower end, and adapted to move from side to side of the slate board, thereby making the necessary circuit combinations. This form was defective for two reasons. The circuits made were not suitable for giving proper speed variations and no adequate means were provided for breaking the arcs formed at the contacts. Several different manufacturers attempted to design controllers of this shape, both for single motors and two motors, but without success.

A more successful series-parallel controller was brought out in 1892, which was located beneath the car and operated by means of rods and bevel gears from either platform. This controller was used in conjunction with the same reverse switch as was used with the rheostatic control. It was expected to fill the great want, but after several hundred had been put into service it was found that improvements were necessary. The starting of the car with this form of controller was jerky, as an insufficient number of points had been provided, while the impossibility of properly installing the controller under the car, so that lost motion in the gears would not be excessive, produced serious burning at the contacts.

This controller contained a magnetic blow-out for disrupting arcs, which was very much superior to anything made previously and which served its purpose in proving the value of the magnetic blow-out. It was also the first controller which shunted one motor in passing from series to parallel.

At about the same time another form of series-parallel controller was brought out by another manufacturer, in which a cylinder was used in conjunction with stationary contacts, or fingers, for producing the different resistance and motor combinations. As it was installed on the car platform it did not require operating mechanisms and was in consequence simpler in construction and not liable to the troubles due to lost motions in transmitting the turning effort from the operating handle. This controller also met with partial success, although the arcing at contacts was considerable, which, in the absence of a magnetic blow-out, caused the principal trouble.

These two forms of controllers clearly demonstrated the practicability of series-parallel control, and demonstrated that the magnetic blow-out to take care of arcing, and the cylinder for compactness and simplicity, were necessities in the design of a controller for operating two

[1] Paper read before the American Railway Mechanical and Electrical Association, Philadelphia, Pa., September 25-28, 1905.

motors of the capacity of about thirty horse-power, then used.

The final outcome of the series-parallel controller for street car service was the present well-known K type, which has been practically standard for about twelve years.

This controller owes its success very largely to the form of magnetic blow-out employed for extinguishing the arcs formed in opening the circuits and the method of making the transition from series to parallel.

Other forms of magnetic blow-outs differing in detail have since been designed which have operated satisfactorily, but the form used in the K type of controllers was the first to be made commercially successful.

In this type of controller, after the motors have reached the full series position, a portion of the starting resistance is quickly reinserted in the circuit and a shunt is put around No. 2 motor by connecting E-1 to ground, thereby eliminating that motor from the circuit, as shown in Fig. 1.

Immediately after this circuit has been established the connection between No. 1 and No. 2 motors is broken, and the positive lead to armature of No. 2 motor is connected to the rheostat, while the line current then passes to No. 2 motor and the motors are in parallel, as shown in Fig. 2.

In the L type of series-parallel controllers, instead of maintaining the current through one motor during the transition, the circuits of both motors are broken. This method of passing from series to parallel was adopted in railway controllers for motors of a total of over 250 horse-power. It was found that the arcing in the controller when using the K-type of connections was too great to permit their use in large controllers.

In the development of multiple unit control it was found that a better method of making the change from series to parallel, which had been proposed before the first K-type of controller was made, was possible with separately actuated switches or contactors. This is what is known as the "bridge method," and consists in keeping the current on both motors during the transition. Each motor is provided with a separate resistance, and when full series has been reached the connections are as shown in Fig. 3.

When passing from series to parallel the first transition step is with resistance for No. 1 motor connected to ground, and resistance for No. 2 motor connected to trolley, as shown in Fig. 4.

It will be seen that this last step has put the two motors in multiple with an equalizing connection between E-1 and the positive side of the armature of No. 2 motor. This equalizer is next open-circuited, and the motors are in the first parallel position.

This method of making the series to parallel change permits a somewhat

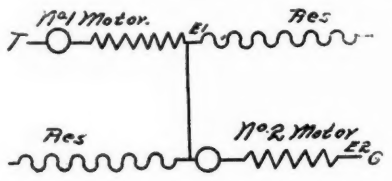


FIG. 4.—SERIES-PARALLEL RAILWAY CONTROLLER.

smoother acceleration than with the K-type of connections, but it is not essential for light equipments where great smoothness is not such an important consideration as on heavy cars operating with multiple unit control.

Several attempts have been made to produce a control which would be still

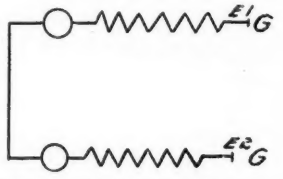


FIG. 5.—SERIES-PARALLEL RAILWAY CONTROLLER.

more economical in use of power than the series-parallel method now in use.

One of these, on which a considerable amount of ingenuity has been expended by different inventors without producing satisfactory results, consisted in providing a "counter-electromotive-force generator" in series with the motors, so that they

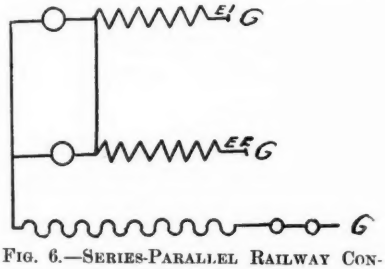


FIG. 6.—SERIES-PARALLEL RAILWAY CONTROLLER.

should not require any resistance to consume energy in starting. This scheme proved complicated and expensive, and in actual service the proportionate time consumed in operating motors at below half speed, or between half and full speed, was so inconsiderable that there was no saving in power of consequence.

Another method, somewhat attractive to those unacquainted with the excessive complications involved, consisted in the use of shunt field motors with control connections arranged for generating current and returning it to the line when stopping the car or descending grades. A number of patents have been taken out for different means of accomplishing this result, and various attempts have been made to produce a satisfactory motor and control.

It is very attractive in theory to be able to make the motors on a car generate useful current, but there are a number of obstacles which have thus far prevented practical realization. The motor must be provided with a shunt field with apparatus for varying its strength, dependent upon the speed while braking, and apparatus must also be provided for giving practically a straight series field for starting.

In addition it is necessary to connect the armatures in parallel and series relation for braking, according to the speed of the car. When the armatures are in series, and the field strength is at a maximum, the minimum car-speed at which current at line potential may be generated is obtained. It is obvious that when the car is moving at a speed less than this critical speed, the motors will be taking current from the line instead of furnishing it.

On a K-10 controller or similar two-motor equipment, it is a well-known fact that in an emergency the car may be stopped when the trolley is off, or main fuse blown, by throwing the reversing handle to its backward position and turning the controlling handle around to multiple. The connections made are such that the two motors are really connected in series, as shown in Fig. 5, but in such a manner that the voltages of the two armatures oppose each other. If these voltages were exactly the same there would be no flow of current, and consequently no braking. As a matter of fact no two motors are identical, and the slight difference in initial voltage gives one motor predominance over the other and determines the direction of the flow of current, one being obliged to reverse its polarity. This can be readily accomplished as the changing motor is operating as a series generator.

If the car is moving at any more than a very moderate speed the current generated by the two motors will almost instantly reach an amount sufficient to slip the wheels. As the momentum of the car tends to throw more than the normal weight upon the front wheels, and relieve the rear wheels of a corresponding weight,

it is to be expected that the rear wheels should slip first.

The instant the wheels slip the motor on the same axle naturally ceases to generate current, but as current from the other motor is flowing through it, it is rotated in the reverse direction as a motor.

It is well for motormen to know that an effective braking can be accomplished in an emergency by this method.

On four-motor equipments where two motors are permanently connected in multiple, it is only necessary to throw the reverse handle to cause the motors to generate, as the circuits are already made, and it is only necessary to reverse the relation of armature and fields.

With a four-motor equipment, care should be taken that the car is brought to rest before the reversing handle is returned to its forward position, otherwise the contacts are liable to be burned. A recent controller, known as the K-28, has been provided with extra air space in the vicinity of the reversing contacts, while barriers are located between them, so that the chance of injuring the reversing switch when "bucking" the motors has been removed.

When motors have been used with electric brakes the controller made connections somewhat different from the foregoing, as it was necessary to vary the quantity of current taken and divide the load equally. Fig. 6 shows the connections.

Electric brakes have not proved very satisfactory, principally for the reason that their action was too irregular, and they could not always be depended upon. In order to generate current satisfactorily it was essential that the commutator should be in good condition. A comparatively slight increase in the resistance of the circuit caused by a dirty commutator or loose connection would prevent a motor from building up at a certain speed.

Due to this irregular action in the motor it was sometimes difficult to make a smooth stop with electric brakes.

It was also found that the high voltage and additional duty imposed upon the motor was productive of commutator trouble and overheating.

The duty required of a street car controller has gradually increased. Instead of two thirty-horse-power motors as formerly, four larger motors are now controlled in the same space. Voltages have been increased and the capacity of the line also raised, so that when an extraordinary arc occurs in a controller from any cause the damage is greater than formerly.

For this reason it is especially necessary to keep fingers properly adjusted, segments renewed and connections tightened to avoid troubles on the road.

There is a growing tendency to place controlling apparatus for large and medium size motors under the car. It removes the heavy capacity parts from the platforms and not only leaves a greater passenger space, but also eliminates all possibility of danger from controller "blow-ups."

Electric Railways in Japan.

Consul Sharp, of Kobé, announces the opening of a new electric road in competition with the state railroad between Kobé and Osaka, Japan. Consul Sharp writes as follows:

"The opening of the Hanshin Electric Railway between Kobé and Osaka marked a great advance in electric traction in Japan, it being the first line constructed in this country to connect two large cities.

"This railway is operated by the electric overhead trolley system with 1,600 kilowatts steam power, and covers a little more than nineteen miles. There are in use at present eighteen cars, which were made by the Nippon Sharyo Seizo Kaisha, of Nagoya, Japan, from a sample car imported from the United States. The cars are well made and have a seating capacity of about fifty. The rails were imported from Pittsburg, Pa., and the motors were imported from Schenectady, N. Y.

"The line is divided into four sections, the fare on each section being two and one-half cents, these being subdivided into one and one-half-cent journeys. All told there are thirty authorized stopping places between the termini, stops being made only when passengers wish to get on or off the cars.

"On the opening day several cars passed eight or nine stations without stopping, and the trip of nearly twenty miles was made in an hour and twenty minutes. The average time, however, is about an hour and a half—half as long again as the time occupied by the steam cars.

"There has been much speculation as to whether the new competing service will not greatly affect the traffic between Kobé and Osaka, on the Imperial government railway. Besides the difference of fare, which is ten cents on the tram and seventeen cents third class and fifty cents first class on the steam cars, the electric cars run every twelve minutes against every hour on the steam railway, and have thirty stopping places as against three.

"On the whole, however, it is more than probable that the new line of cars will cause a very considerable diminution in the receipts of the government railway between these two cities.

"The amount of paid-up capital in this company is $742,500."

The Independent Telephone Association of Southern Indiana.

At the recent meeting of the Independent Telephone Association of Southern Indiana, held at New Albany, September 18, topics of general interest to telephone companies were discussed. It was decided to dissolve the association in order to allow the various companies comprising the membership to become members of the Indiana Independent Telephone Association. A committee appointed to propose and prepare a memorial reported the following, which was unanimously adopted:

"Your committee, to whom was referred the matter of dissolving the Independent Telephone Association of Southern Indiana, with a view of making application to become members and part of the Indiana Independent Telephone Association, begs leave to report that, after having given the matter due consideration, it concludes that it would be to the best interests of the different telephone companies comprising the Southern Indiana Telephone Association that this association be dissolved, and that each company comprising the same make application to become a part of the state association. Therefore be it

"*Resolved*, That the Southern Indiana Telephone Association be now dissolved, and that each member thereof make application to become a part of the said state association, all of which is respectfully submitted. (Signed) A. J. Payton, J. A. Armstrong, H. C. Roberts, committee."

In the evening the New Albany Home Telephone Company gave the visitors a "Dutch lunch" and smoker at Mannœrchor Hall, which was greatly enjoyed by all present.

Maps of the Independent Telephone Systems.

The National-Interstate Telephone Association has begun the preparation of maps showing the independent telephone development throughout the country. These maps are being made up from data which the association has satisfied itself are absolutely reliable. When the maps are completed they will be an accurate record of the existing independent lines throughout the country, and the maps will be constantly kept up to date, new lines being added as rapidly as completed and reported.

While there is sufficient data on hand to go ahead with this work, it is not as extensive nor as specific as is desired. The association has issued a request that every independent company in the United States send a map of all toll lines which it operates, dividing the lines into two classes: copper lines of No. 10 gauge or heavier, and copper lines of No. 12 or No. 14 gauge and all iron lines.

Electrical Notes from Europe.

By Our Special Correspondent.

IT IS stated that a system of wireless telegraphy is soon to be in operation from Iceland to the Continent. The stations are now underway and it will not be long before Iceland will thus be put in communication with different points of Europe. The different towns of Iceland will also be connected with each other, and the large towns will be equipped with stations containing the most recent apparatus. As to the system of wireless telegraphy which is to be used in the different stations, it is probable that they will make use of the Marconi or the German Telefunken apparatus.

Monophase current is to be used on an interurban road which connects Vienna with the town of Baden. The line which now runs between these two points has been using a steam system for the interurban part, while the portion lying within the cities is run on the direct-current system. The distance is some seventeen miles, with double-track having a maximum grade of 2.8 per cent. The tramway rails are used inside the towns, while the rest is the usual standard gauge track. Current for the latter portions is supplied in Vienna from the main city plant for 2.6 miles of line, and in Baden for 1.2 miles from the station of the local tramway. The interurban part of the line which is some thirteen miles long is now to be run by a single-phase system, using 500 volts on the motors. The motor-cars to be used in this case are of the double bogie pattern and each is equipped with two series motors. The Siemens-Schuckert Company has designed this apparatus. Each of the motors has a capacity of thirty-six kilowatts. The motors are built so that they can be used either for direct or alternating current and are coupled in series or in parallel, along with the proper resistance coils. The central station for the line is located a mile or more from Baden. The outfit will consist of two alternators of 200-kilowatt capacity each, which are to deliver 10,000 volts, also a direct-current generator of 165-kilowatt capacity, working at 550 volts. The station will also contain two rotary converter groups. Each of these is composed of a monophase synchronous motor of 150 kilowatts capacity, working at 10,000 volts, and a direct-current generator of 100 kilowatts capacity at 500 volts. A battery of accumulators is used in parallel with the converter groups. The tension will be lowered at a certain number of points along the railway line by transformers of the oil pattern having 110 kilowatts capacity which will receive the main voltage of 10,000 volts from the station. The cars are to be equipped with transformers having a number of loops on the secondary so that the voltage on the motors can be raised or lowered from the normal point. It is expected to run express trains between Vienna and Baden at thirty miles an hour, besides ordinary trains.

Professor W. Kübler has recently carried on a number of experiments between Dresden and Berlin with newly designed aerial telegraphy apparatus in order to determine whether the waves are stopped to any great degree by obstructions of different kinds which may lie between the two signaling stations, such as the buildings of the cities, elevated structures, mountains, forests, etc. According to the experiments which were made in the present case using the Telefunken system of apparatus, it appears that obstacles of the above nature do not seem to have any great effect in diminishing the strength of the waves. The experiments were carried out with apparatus which was designed by the German Wireless Telegraph Company.

A large plant has been lately erected at Zürich for consuming household waste and obtaining electrical energy. The plant is now operating twelve of the large garbage furnaces which have been constructed by an English company, the Horsfall Destructor Company, of Leeds. The furnaces are placed in two groups, and are capable of burning some 150 tons of waste material in twenty-four hours. An electric crane takes the receptacles containing the garbage off the trucks and brings them over the furnaces, where they are dumped, and the man in charge spreads the material over the grate so that it will burn properly. An electric fan creates a strong draft and gives a good consumption of the material on the grates. Hot air is drawn from the furnaces by a series of conduits and is brought to the boilers in order to heat them. The conduits lead to two multitubular boilers of some 200 square yards heating surface each, which deliver steam at a pressure of eight atmospheres. The steam is then superheated to 250 degrees centigrade and is used to operate a steam-turbine group in the dynamo room. The latter consists of a Brown-Boveri turbine which operates at 3,000 revolutions per minute. The dynamo is a three-phase alternator, running at 220 volts and fifty cycles. Its capacity is 500 kilowatts. Part of the current furnished by the turbine groups is used to operate the electric motors which are needed for handling the material and running the furnaces, while the remainder is distributed on the city mains. The slag and cinders from the furnaces, which forms some thirty to forty per cent of the original weight of the material, is utilized in various ways. It is said to be used as a building material to good advantage.

M. D'Arsonval recently showed a new speed indicator before the Academy of Sciences at Paris. It is used for making accurate tests upon engines or electric motors. The device works on the differential principle, and the motor under test is made to work against a standard motor, so that when it runs at the normal speed the needle indicates zero, and when it departs from this, the amount is shown on the dial. One wheel of the differential mechanism is driven from the standard motor, which in this case is a clockwork device, by means of an appropriate combination, while the other wheel of the differential is operated by the motor in question. A regulating device is used to adjust the speeds properly. When the test motor runs at the same speed as the standard, the differential remains at rest and the needle which it carries is at zero on the dial. Should the motor depart from this speed the differential moves to a certain extent, which the needle shows. The instrument is very sensitive, and will show a small variation of speed. It will no doubt be of service in making accurate tests upon motors.

The Berlin subway is now being extended from Potsdam Place to Spittelmarket. The new section has not a very great length, not much over a mile, but owing to the character of the ground it appears that this part of the line is giving considerable difficulty and the tunnel is being put through very slowly. In this part of town the foundations of the buildings lie in the way and a great deal of work is required here, which entails a heavy expense. At the present date a

portion of the tunnel has been already finished, but they have encountered two blocks of houses which are giving some trouble, and it will no doubt be some time before the section will be completed.

It is proposed to utilize the falls of the Maria river, in the southern part of Switzerland, for operating a hydraulic plant and in this way a large amount of power can be secured. This is estimated at no less than 32,000 horse-power available, if the hydraulic part is carried out under proper conditions. As the flow of water is very irregular, it will be necessary to provide a reservoir to equalize the output. The falls extend over a distance of ten miles. The most rapid parts lie near Vicosoprano and Promontogno where the grade reaches over nine per cent. It is proposed to take advantage of a lake which lies nearby and use it as the regulating reservoir. This lake formerly received the Maria river and its affluent, the Orlegna, and all that is needed is to adapt the old bed of the river as a canal to bring the water again into the lake, giving it a slight grade for a length of 1.5 miles. In this way a nearly constant flow of water can be secured at all seasons. The power can be utilized in one or two hydraulic stations.

At the Liege exposition were noted several large gas engines which are built by the Cockerill Company, of Searing, Belgium. This company has been making a specialty of engines of large capacity which use blast-furnace gases or producer gas. An engine of 1,200 horse-power for blast-furnace gas is especially remarked. It has one-metre cylinder diameter and 1.10 stroke, operating at 100 revolutions per minute. Another engine of smaller size, also of the horizontal type, is designed to use gas from a coke furnace, and is built to be used with dynamos. Here the cylinder bore is 0.60 metre and stroke 0.80, working at 135 revolutions per minute. Electric ignition is used in this case and it is operated by a cam shaft. The sparking moment can be adjusted as desired. A constant pressure of gas at the inlet to the motor is assured by a centrifugal governor. The engine is started up by compressed air, which is delivered from a separate compressor. The Cockerill Company has also built a smaller engine of 150 horse-power and 280 revolutions, which runs with blast-furnace gas.

The Allgemeine Electric Company has been making some experiments with the use of steel wires and cables for carrying current. It is evident that there would be a great advantage in using steel wires in cases where a long span is required, especially on high-tension lines. But the drop in such lines, due to induction, would seem to be an obstacle here. The experiments were made in order to find out whether the inductive drop would make the use of a steel span prohibitive or not, and it appears according to the results which were obtained that part of the drop which is in excess of the ohmic resistance of the wire is not as high as might be supposed. It naturally increases with the current and the section of the wire, but it is found that with a given section and current it can be greatly reduced by using a cable made up of a number of strands of fine wire.

The submarine cable, which is being laid in the Mediterranean, between Costanza, in Roumania, and Constantinople, is the last as well as the most important section of the direct telegraph line between Berlin and Constantinople. The cable is laid for the East European Telegraph Company. It has been constructed in Germany, at the Nordenham submarine cable works. The company is to run a land line from Constantinople, which will traverse Asia Minor and Syria, running as far as the northern Sinai region.

It appears that a large syndicate has been formed for constructing the new Zoelly steam turbine. The syndicate includes the Krupp firm, the Augsburg-Nürnberg Machine Company, the North German Lloyd, the Escher-Wyss firm, and the Siemens-Schuckert Company. It is to construct the Zoelly turbine in Germany and adapt it for different uses, especially for the marine and for electric plants. The syndicate will carry on affairs on the Continent with the exception of France, where the turbines are to be controlled by the Schneider Company, of Creusot. According to recent reports, the Zoelly turbine is in use or building by the firms mentioned above to the extent of 25,000 horse-power. An English syndicate has also been formed, including the Escher-Wyss Company, A. G. Schiff & Company and Mather & Platt, of Manchester.

Next year is to be held the fourth congress of Russian electricians at Kieff, from April 2 to April 15, under the auspices of the Imperial Technical Society. The government is represented by the minister of the interior and finance. The object in holding the congress is to bring together the persons interested in electrical matters from all parts of Russia, and to consider the questions which will promote the interests of the science, industry and technical instruction. One feature of the congress is an exhibition of electrical and kindred inventions and appliances. It is expected that other nations will be represented at the exhibition, and it has been decided that apparatus will be imported for this purpose free of duty, provided it is exported at the end of three months, and freight will be free as far as the frontier. The exhibition opens March 25 and lasts for three months. Other technical congresses are to be held on this occasion. The president is the mayor of Kieff, Dr. Prozenko.

The Oerlikon Company has been using a system of endless screw transmission for electric cars, which seems to be quite successful. Tramway cars have been operated on this system for some time past, and the motor drives the axle by means of an endless screw instead of by the usual form of gearing. On the Zürich-Seebach line there are a number of such cars in operation. The screw is made to run in ball bearings, and is provided with oil-rings. The motor is connected to the screw by means of a flexible coupling.

C. L. DURAND.

PARIS, October 1.

Utilizing Scandinavian Rivers.

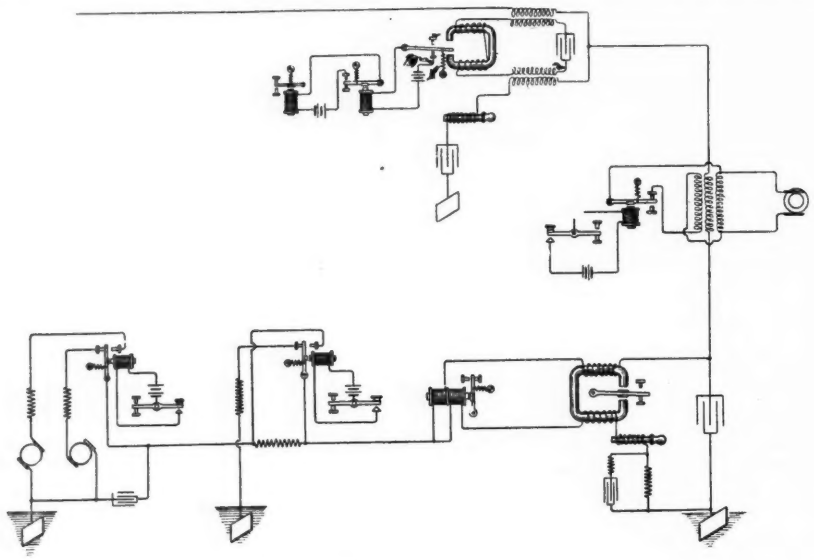
Sweden is planning to use all the water now going to waste over her falls and in the rivers for the generation of electrical energy. Engineers are in the hills making surveys, and capital is getting ready for the call that will come when the surveys are completed. The same may be said of Norway, where the waters have shorter distance to run, but are often of large volume. In Sweden the power will be put to work in all manner of mills; in Norway, in the iron and copper mines. The movement in Norway is being backed by foreign capitalists, particularly Americans.

A New Atlantic Cable Laid.

The steamer Colonia, which sailed from Canso, Nova Scotia, on September 23, paying out the Commercial Cable Company's new Atlantic cable, reported on October 3 that it had arrived at a point 187 miles from the Irish coast, where it would make a final splice between the 2,000 miles of cable which had been laid from the American side and the 187 miles laid from the Irish coast by the steamer Cambria last June. This will make the fifth Atlantic cable laid by the Commercial Cable Company.

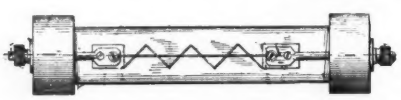
Electrical Patents.

Sterns F. Jones, of New York, N. Y., has assigned one-half interest in a patent to the Postal Telegraph-Cable Company, of New York, N. Y. (799,237, September 12, 1905). This invention relates to that class of apparatus in which two or more sets of signals are simultaneously transmitted on a single main line. The object of the invention is to increase the capacity of the telegraph circuits and also to improve the effectiveness of the transmitted signals. It consists of a suitable telegraph line or circuit, means for transmitting signals consisting of a source of short and rapid current alternations and a suitable transmitter for throwing said alternations onto the line in groups of varying length and sequence, and at a receiving station a suitable relay in a balanced separate circuit and means for inductively connecting said circuit with the main and branch lines.



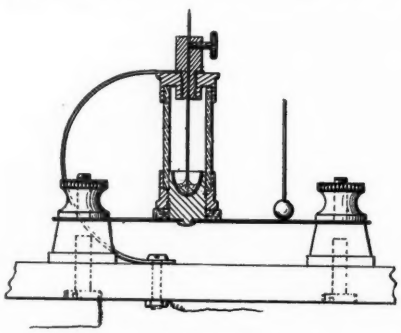
TELEGRAPHY.

Henry N. Snyder and Lewis A. Hardison, of Santa Paula, Cal., have invented an electric fuse (799,684, September 19, 1905). This invention relates to improvements in mounts or holders for fusible conductors of electric cutouts, and particularly to that class of such devices in which the fuse is entirely enclosed and so mounted that it may be readily renewed when destroyed or damaged. The object of the invention is to provide a device of this character which will be simple in construction, durable in use, efficient in operation, and comparatively inexpensive to manufacture. It comprises a tubular body having screw-threaded ends, screw caps for closing said ends, a zigzag fuse-support of non-conducting material within the body, the support having a longitudinal bore therethrough, electrical conductor terminals secured upon the ends of the support and having screw-threaded ends projecting through said screw caps, clamping nuts upon the outer ends of said terminals, a fusible conductor passing through the longitudinal bore and connecting the inner ends of the terminals, and a liquid in the body surrounding the fusible conductor and the support.



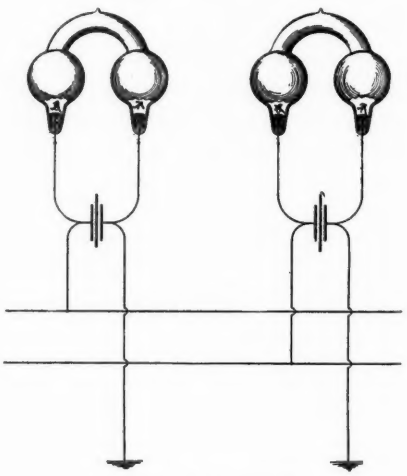
ELECTRIC FUSE.

Walter W. Massie, of Providence, R. I., has patented a coherer (800,119, September 19, 1905). This invention relates to coherers for use in wireless telegraphy. One of the objects of the invention is the provision of means for securing a wide range of adjustment by having the filings containing-cup so shaped or formed as to obtain a variation of resistance. This is done in the present case by making the cup of progressively increasing cross-sectional area from its bottom toward the top, so as to provide for a variation in upper surface area of the mass of filings and naturally for a variation in resistance. Another object is to provide a simple device of this character which is effective in operation and wherein the parts can be readily assembled to present an operative organization and as easily separated when occasion requires. It consists of a tube, a collar fitted to one end of the tube, a needle extending into the tube, and a carrier for the needle, having a threaded engagement with said collar, a conducting strip clamped to the collar by the needle carrier and notched to receive the latter, a bridge to which the coherer is permanently connected, supports to which the bridge is detachably connected, one of the supports constituting a terminal, and a screw constituting another terminal, electrically connected with the conducting strip.



COHERER.

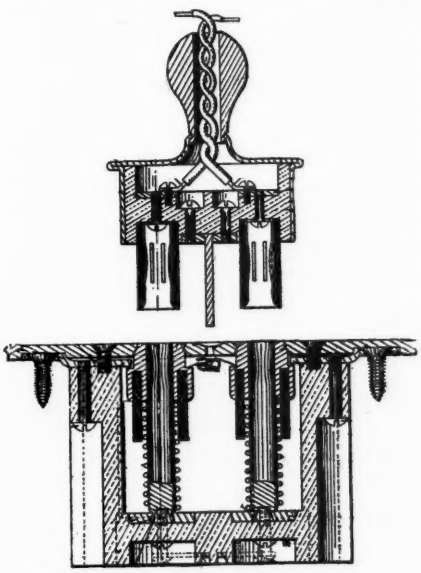
Peter Cooper Hewitt, of New York, N. Y., has assigned by mesne assignments, to the Cooper Hewitt Electric Company, New York, a patent on a lightning arrester (799,049, September 12, 1905). The characteristic possessed by the gas or vapor apparatus which has been patented to this inventor in a number of United States patents—for instance, certain patents issued on September 17, 1901, namely, the characteristic of possessing a high initial resistance which has to be overcome before the apparatus will act as a true vapor conductor—may be made use of in providing a lightning arrester for electric circuits; and the object of the present invention is to disclose a mode of utilizing this characteristic for the purpose described. The invention consists of a pair of electrical conductors forming the mains of an electric circuit, a light-



LIGHTNING ARRESTER.

ning arrester connected with each member of the pair, each lightning arrester comprising a pair of electrodes, at least one of which is vaporizable, enclosed in an hermetically sealed tube or container and a vapor intervening between the electrodes, the vapor in each container possessing an initial resistance incapable of being overcome by the normal line potential, but capable of being broken down by an abnormal potential.

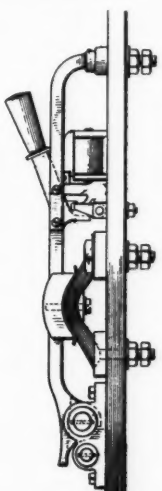
Nathan W. Crandall, of Hartford, Ct., has assigned, by mesne assignments, to the Perkins Corporation, Hartford, Ct., the interest in a patent obtained by him on an electric cutout switch (800,609, September 26, 1905). The invention relates more particularly to that class of electric switches which are commonly



ATTACHMENT PLUG AND RECEPTACLE.

termed "cut-outs." In this device a box or receptacle is employed into which a portable plug is inserted for the purpose of introducing into an electrical circuit any electric device (at a predetermined location) and in such manner that it can be readily and easily withdrawn or cut out at will. These receptacles are located at frequent intervals along an electrical circuit line to permit of the introduction and connection of portable plugs at any desirable points. The object of the invention is to produce a simple, compact, durable and efficient device of the character described which can be cheaply manufactured and which will be practically dustproof, the perforations in the escutcheon or receptacle cover, through which the portable plug is inserted, being automatically sealed when the terminal is withdrawn therefrom. The invention consists of a non-conductive receptacle provided with a perforated escutcheon-plate, stationary terminals being located in this receptacle. A movable contact member is also located in the receptacle and is seated in a perforation in the escutcheon. A spring in the receptacle is arranged to normally hold the conductory member against the escutcheon-plate. A portable plug is provided with a guide-bar adapted to register with and pass through a perforation in the escutcheon and to move with and guide the terminal in its passage through the perforated escutcheon-plate to coactively move the movable contact member into contact with the stationary terminals.

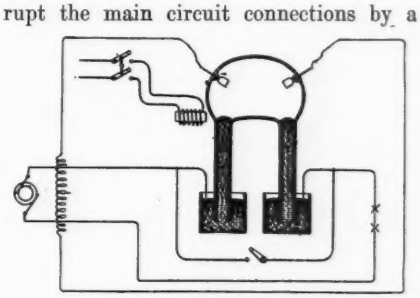
Henry H. Cutler, of Milwaukee, Wis., has assigned to the Cutler-Hammer Manufacturing Company, of Milwaukee, Wis., the patent on a multiple switch (799,721, September 19, 1905). This invention relates to a multiple switch, and more particularly to a multiple switch designed for use in connection with rheostats. It has been proposed heretofore to associate the resistance of a rheostat with a plurality of switches, whereby the switches may be closed one at a time and in a definite order to cut out the resistance of the rheostat. The present invention is particularly designed for employment in connection with rheostats having this characteristic; and one of the objects of the present invention is to provide a means



MULTIPLE SWITCH.

whereby the operator is compelled to close all of the switches of the rheostat when starting a motor and prevent the leaving of any of the starting resistance in circuit, whereby they might become overheated and destroyed. In accordance with the present invention the multiple switches are arranged so that the same can be closed only in a definite order, and, furthermore, is provided a means whereby the switches are adapted to be maintained in a closed position and automatically opened at the desired time. It further provides a means whereby before the switches will be retained in their closed position it is necessary that every one of the switches be closed. It consists of a plurality of switches arranged in a mechanical series, of means for preventing the closure of the same except in a definite order, electromagnetic retaining mechanism for holding said switches in a closed position, and means whereby the retaining mechanism will be operative only when the last switch of the series is closed.

Peter Cooper Hewitt, of New York, N. Y., has assigned to the Cooper Hewitt Electric Company, of New York, a patent on a circuit controller (799,050, September 12, 1905). This invention relates to an improved type of electric switch for controlling circuits in which currents of high potential or large quantity are carried. The invention is applicable to various different classes of electrical circuits and has special advantages in connection with power circuits or circuits carrying currents of such voltage and quantity as to render it difficult to interrupt the main circuit connections by a



CIRCUIT CONTROLLER.

switch or circuit-breaker without undue sparking at the contact-plates. The significant feature of the switch is that of introducing into the circuit to be controlled the resistance of a gas or vapor electric apparatus under such conditions as will, for example, stop the current-flow in the circuit without the development of any deleterious sparking and without causing a dangerous rise of potential in any part of the circuit. It consists of a system of electrical distribution wherein an enclosed gas or vapor is included, or adapted to be included in the system, the method of rupturing a circuit carrying a current of high potential or large quantity, which consists in shunting a portion of the current through the conducting gas or vapor, thereby creating a path of determinate resistance in the shunt circuit, opening the shunted portion of the main circuit and afterward rendering the gas or vapor non-conducting with relation to the energy applied.

Reviews of Current Engineering and Scientific Literature.

Studies of Luminescence.

A further contribution is made here by Dr. E. L. Nichols and Mr. Ernest Merritt to the study of luminescence. The phosphorescing substance used for these investigations was Sidot blende or phosphorescent zinc sulphide, which was caused to phosphoresce when excited by Rœntgen rays or radiations from an electric arc. The light radiated was examined spectroscopically. It was found to vary in quality as the luminescence decayed, and seemed to consist of separate bands which responded differently to various excitations. The authors conclude, however, that the spectrum of each band does not change during the decadence, but that certain of the bands decay more rapidly than others. This would account for change in color of the light as the phosphorescence dies out. It is thought that the behavior of Sidot blende is typical, and that in no case of phosphorescence is there any change in the form of the spectrum. The authors are convinced that the use of the unaided eye in the study of luminescence may lead to serious errors because of the faintness of the light as the phosphorescence dies out.—*Abstracted from the Physical Review (Lancaster), October.*

The Siemens & Halske Printing Telegraphic Apparatus.

A description is here given by M. Emile Guarini of the printing telegraph lately brought out by Siemens & Halske, of Berlin. This is an automatic system resembling the Wheatstone in one respect, in that it requires first the perforating of a strip of paper, which is then passed through the sender. The perforator is a device resembling somewhat the typewriter, which punctures two holes for each letter, following an oblique line. The styluses are operated by keys, and the paper is moved forward by a small electric motor. To enable the punctured strip to be read easily, the perforator prints the message on the strip at the same time it punctures it. The punctured message is placed in a transmitter, where it is drawn along by a motor in front of a system of eleven springs. As the punctured strip passes under these springs, two signals—one delayed slightly behind the other—are sent out, one being a positive discharge, and the other a negative discharge into the line. There is, in addition, a transmitting disc used for making the signals more precise. This disc determines the duration of the discharge into the line. At the receiving end is a printing device driven in synchronism with the transmitter. Synchronism is maintained by an electromechanical governor. The discharges into the line are received in a relay which operates an automatic receiver comprising a motor rotating at 2,000 revolutions per minute; four discs, two of which are for producing rapid electrical discharges, and a type wheel, upon the periphery of which are distributed the letters of the alphabet. These letters are arranged in a spiral, so that the signals, as printed, will be equally spaced. Printing is accomplished photographically by causing a discharge to take place when the signal to be reproduced is opposite the receiving strip.—*Abstracted from the Electrical Review (London), September 22.*

The Walthamstow Electric Lighting and Tramways Undertakings.

The Walthamstow Urban District Council's tramway system was put into service last June, thus adding another much needed but long delayed improvement in the local traveling facilities of northeast London. In addition to its interest as one of the recent English tramways, it is the largest gas-driven station in England. The engine room contains thirteen generating sets, each consisting of a Westinghouse three-cylinder gas engine direct-coupled to a Helios direct-current dynamo. Seven of these sets comprise the older part of the plant, and consist of four 450-horse-power and three 250-horse-power units. These are utilized entirely for lighting purposes. The six new units, three of which are intended for lighting and three for operating the railway, are of the Westinghouse vertical, single-acting, three-cylinder type. The cylinders are twenty inches in diameter, and have a stroke of twenty-two inches. Two nine-foot flywheels are fitted to each engine. They have an overload capacity of twenty-five per cent. Low-tension electric ignition is provided. The ignition sets are made up of a small 200-volt motor driving a generator which gives eight amperes at three-sixteenths volt. These igniters may be coupled together through a common ignition bar running the length of the station. The engines are started by compressed air, which is stored in tanks at 200 pounds pressure per square inch. The compressors are driven by motors. The gas for driving the station is generated in eight producers of the Dawson type, arranged in two houses, each with a complete equipment of purifying plant and two gas-holders. The more recently equipped producer house contains four 350-horse-power generators, each capable of consuming 500 pounds of anthracite coal per hour. Each generator is provided with three coke scrubbers, a washer and a sawdust scrubber. Each generator house is provided with a twenty-five-foot gas-holder. These generators supply gas having one-fourth the thermal value of coal gas, at a cost of four cents per thousand cubic feet. The fuel consumption of the engines is said to be less than one pound per brake horse-power-hour. The railway section of the power-house is supplied with a traction battery and charging boosters. The lighting section also has a battery, though of smaller size. The overhead structure of the railway is mostly of the bracket type. At the various termini, automatic trolley reversers are fitted. The trolley brackets are used for suspending the street arc lamps.—*Abstracted from the Electrical Review (London), September 15.*

An Electrostatic Voltmeter for 200,000 Volts.

An electrostatic voltmeter for measuring high potentials has been devised by M. M. Jona. The apparatus is of the balanced type, made in two styles—one for potentials not over 100,000, and the other for voltages up to 200,000. The moving parts of the two instruments are practically identical, the only difference being in the arrangement of the supports and the fixed electrode. The moving part consists of a metallic cross supported on jewels. To one of the horizontal arms is attached, by a thin wire, a movable plate. To the opposite arm and to the one standing vertical are attached movable weights, so as to adjust the sensitiveness of the instrument. The lower arm is used for supporting various weights, so as to change the range of the instrument. The movable plate hangs within a glass enclosure. For the lower voltages it is surrounded by a metallic cylinder, which maintains a uniform potential about it. Through the base of the glass containing-vessel passes a metallic connection to the second electrode or fixed plate. This plate is mounted on an ebonite column held

in position at a sufficient distance from other metallic portions of the instrument to prevent sparks from jumping. The containing-vessel may be filled with oil if desired, but this has a disadvantage, since the dielectric constants of oils vary. In the second instrument the movable portion is itself mounted on a tall ebonite column. The movable plate hangs within a glass vessel. The fixed plate is a sheet of tinfoil placed in the bottom of the vessel, and having no outside metallic connection. A second sheet of tinfoil is placed beneath the containing-vessel, and to this is attached one terminal of the instrument. There is really no need for the inner sheet of tinfoil, but it is advantageous because it gives a more uniform distribution of potential within the vessel. The instrument is read by means of a long pointer attached to the metallic cross, and which swings over a fixed scale.—*Translated and abstracted from L'Industrie Électrique (Paris), September* 10.

The Cleaning and Agglomeration of Ore Dust.

A description is given here of a concentrating and smelting plant at Niagara Falls which makes use of the Ruthenburg processes. The ore concentrated is a fine dust containing sand, which must be got rid of before it is a valuable product. The tailings are also valuable from the copper content. The first step in the process is to remove the sand. This is done by means of a magnetic separator, which consists of a revolving electromagnet driven on a horizontal axis by means of an electric motor. Over this is placed a metal apron which, on one side, leads to a bin for the concentrates, and on the other to a shallow trough into which the dust is fed. The dust is stirred and pushed along this trough by means of a conveyer. When the magnet is revolved, the magnetic particles of ore are attracted by it, and, as each pole approaches them, rise, stand on end, and then fall flat in the other direction, rising again as the next pole approaches. In this way, by a series of somersaults, they march up the metallic apron in a direction opposite to the motion of the magnet, pass over the top, and fall into the concentrate bin. This concentrator is said to be very effective in removing silicious matter and phosphorous impurities. After concentration, the ore, being in a powdered condition, requires special treatment before it is suitable for the smelter. This is accomplished by means of the Ruthenburg electric melter, which has been described recently. In brief, it consists of an electromagnet having two cylindrical parallel electromagnets, the poles of which are cylindrical and arranged side by side. These poles also serve as the electrodes for passing heavy currents through the magnetic ore as it is passed between them. The particles of dust form bridges across the poles, through which the current flows, partially melting them, when they become non-magnetic and fall into a receiver placed below, in the form of beads.—*Abstracted from the Iron Trade Review (Cleveland), September* 14.

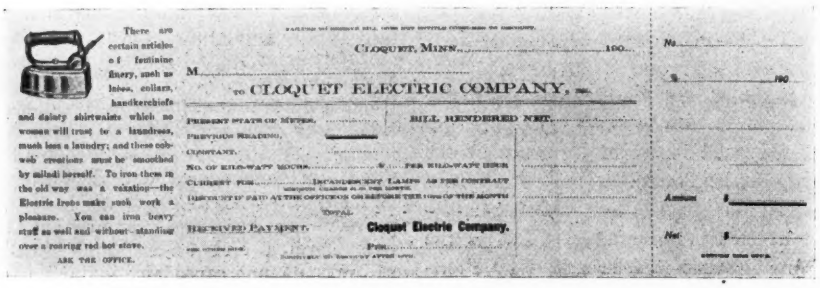
The Work of the Physikalische-Technische Reichsanstalt.

The annual report of the work of the Physikalische-Technische Reichsanstalt, of Charlottenburg, has been issued. A digest of this is given here. This is the last report that will be signed by President Friedrich Kohlrausch, as he retired at the end of March of this year. He has been succeeded by Professor E. Warburg. The report takes up in detail the work of the various departments of the institution, those of particular interest to electrical readers being the physical and electrical sections. The electrical researches have shown that the mercury and manganin standard resistances have been made practically constant. As regards standard cells, the report is disappointing, as the troubles caused by the mercuro-sulphate do not at all appear to have been overcome. Von Steinwehr finds that the conductivity of a saturated solution of mercuro-sulphate does not fluctuate as long as there is some non-hydrolyzed salt present. For this reason, among others, the Reichsanstalt opposed at St. Louis the proposal to adopt the Weston cell as a standard. It also held that this proposal was not consistent, since it required the adoption of three interdependent units. The polarization of the Clark cell is being investigated by Jaeger and Steinwehr. Their results are in better agreement with theory than some previous researches. The polarization proves to be proportional to the current density. The anodic or cathodic polarizations are equal to one another and of opposite sign, and the currents for the rise and fall of polarization always supplement one another. Cells containing coarsely grained salts polarize more than cells with fine grains of salt, but the difference disappears in a few days, when the larger crystals will be found to have increased in number at the expense of the smaller crystals. Kohlrausch and Grüniesen have proved that the empirical formula for the conductivity of salt solutions of monovalent elements which was proposed some time ago can be applied to salts containing bivalent and monovalent elements. At higher dilution the calculated conductivities are too great; and as regards salts of bivalent elements, the range of applicability is still more limited. Radium bromide behaves normally and similar to barium salts. Oxalates, particularly magnesium oxalate, show interesting peculiarities as regards conductivity and solubility. Magnesium oxalate is hardly soluble in water, which dissolves only one-third per cent of the salt; but, under certain circumstances, it is possible to prepare solutions containing ten per cent of the salt, which solutions are therefore super-saturated 300 times. These solutions resemble colloids somewhat. The torsion magnetometer of Kohlrausch, Holborn and Henning has been improved. It has been found that the new elevated and underground electric railways do not cause any magnetic disturbances at the laboratory. For the study of temperature radiation the "black body" is being improved, with the object of economizing electric current. Preliminary experiments with a black body consisting of incandescent oxides have not given satisfaction. The enquiry into the accuracy of the spectrobolometer has been satisfactory. Its results agree with Planck's equation. Experiments on the stratification of the electric discharge have shown that the cross-section of the tube, or, in other words, the nearness of the glass walls, has a decided influence upon the stratification. The striæ appear to represent a series of secondary cathodes which owe their existence to the discharge of negative electrons from the real cathode. In the electrical testing laboratories a large number of scientific and commercial instruments have been tested, and an investigation into the constancy of commercial electricity meters has been made; but the reports are confidential. A Blondel oscillograph has been subjected to tests, and found satisfactory up to frequencies of 10,000. An investigation is being made into the distortion of electric waves of inductive circuits containing no iron. The Weston standardized cells owned by the Reichsanstalt have been tested again. The Reichsanstalt declares its preference for the Weston cell, but it regrets that in the type furnished by the Weston Electrical Instrument Company some evaporation of water takes place. A modification has been devised which is free from this defect. A comparison of the wattmeter and ballistic methods of testing iron for hysteresis has been made. The same results were obtained with each method for densities of from 4,000 to 16,000 per square centimetre. It was found that iron is not magnetically less soft to rapid current alternations than to continuous currents, and that the permeability does not become smaller at higher frequencies.—*Abstracted from Engineering (London), September* 8.

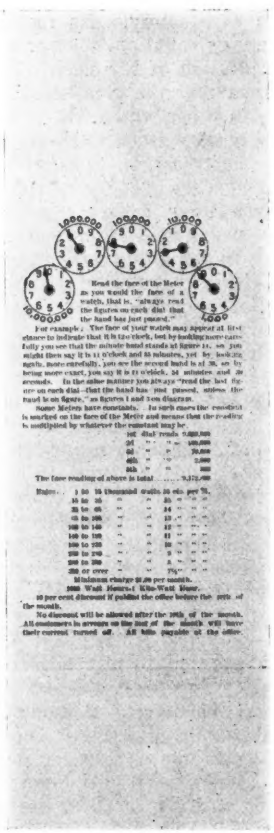
Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

In seventeen of the leading cities of the United States, outside of New York, the money expended for the construction of new buildings amounted to $50,000,000 more than for the summer building season of 1904. The opportunity for the installation of electric service in these new buildings alone is certainly encouraging. Some electric companies have one man who watches the filing of plans and specifications, and, at the earliest possible moment, consults with the architect as to the advisability of depending upon a reliable central station service, rather than going to a large first cost in installing an isolated plant.


There are certain articles of feminine finery, such as laces, collars, handkerchiefs and dainty shirtwaists which no woman will trust to a laundress, much less a laundry; and these cobweb creations must be smoothed by miladi herself. To iron them in the old way was a vexation—the Electric Irons make such work a pleasure. You can iron heavy stuff as well and without standing over a roaring red hot stove.
ASK THE OFFICE.
CLOQUET, MINN., 190
M
TO CLOQUET ELECTRIC COMPANY, Dr.
PRESENT STATE OF METER.
BILL RENDERED NET.
PREVIOUS READING.
CONSTANT.
NO. OF KILO-WATT HOURS.
CURRENT FOR
INCANDESCENT LAMPS AS PER CONTRACT
TOTAL
RECEIVED PAYMENT.
Cloquet Electric Company.
No.
$
190
Amount $
Net $

METER BILL ISSUED BY THE CLOQUET ELECTRIC COMPANY.


Read the face of the Meter as you would the face of a watch, that is, "always read the figures on each dial that the hand has just passed."
Some Meters have constants. In such cases the constant is marked on the face of the Meter and means that the reading is multiplied by whatever the constant may be.
Rates:
Minimum charge $1.00 per month.
10 per cent discount if paid at the office before the 20th of the month.
No discount will be allowed after the 20th of the month.
All customers in arrears on the first of the month will have their current turned off. All bills payable at the office.

REVERSE SIDE OF CLOQUET ELECTRIC COMPANY'S METER BILL.

The introduction of prepayment wattmeters will, no doubt, help considerably in increasing the popular use of electricity, both for business and residence lighting. Between seventeen and eighteen years ago the first prepayment gas meter was built in England. Within the last decade over half a million prepayment gas meters have been built and sold in this country. Of the registering appliances which have been devised to increase the confidence of the purchaser that the supply company was dealing fairly with him, nothing has so stimulated this confidence as the prepayment meter. The prepayment wattmeter is not only what many customers desire, but it is also a valuable asset to the supply company. The purchaser pays for what he receives, and the apparatus does away with bad bills and much of the chronic fault-finding which comes with all forms of public service.

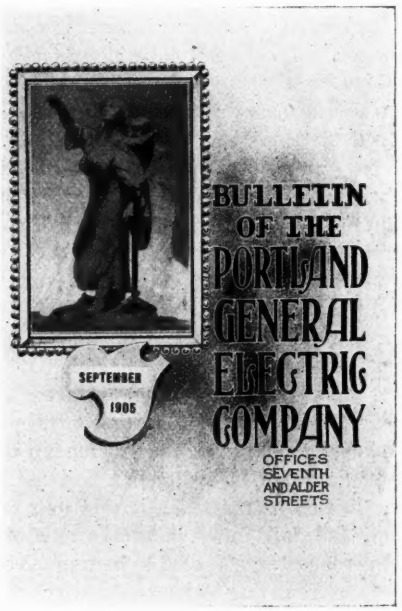
The following communication has been received from a person prominently engaged in the electrical development of central stations:

"I notice with much pleasure your 'New Business' department you issued on September 30, and desire to express my appreciation of your prompt action.

"I believe you can make this section the most widely read and valuable section of your paper."

The Cloquet Electric Company, Cloquet, Minn., has hit upon a good plan for keeping in the mind of the consumer the various advantages of the electric current. As each meter bill is presented, the customer is made acquainted with some new phase of the use of electricity. The accompanying illustration shows the advertisement of an electric laundry iron, with a brief paragraph setting forth the need for such an apparatus. Another bill contains a description and an illustration of a very dainty electrical heater. Still another contains a description and an endorsement of an electric warming-pad, while another presents the attractiveness of an electrically operated chafing-dish. On the reverse side of the meter bill there is an illustration of the dials on the service meter. A careful explanation of the method of reading is added, and a compilation of the methods of charging is given.

The Portland General Electric Company, Portland, Ore., distributes an attractive bulletin calling attention, in various ways, to the utility of the electric service. Illustrations are given showing store signs, electrical decorations, etc., and articles such as "Economy of Electric Service in the Household," "Useful Electric Furnace," "Electric Chafing-Dish Dainties," and Chain-Making by the Electric Process," are included.



A BULLETIN PUBLISHED ON THE PACIFIC COAST.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Pendant and Knife Switches.

In addition to its well-known pendant push-button type, the General Electric Company, Schenectady, N. Y., is now manufacturing a pendant key-type switch. This form of switch is particularly designed for use where an inexpensive switch

KEY-TYPE PENDANT SWITCH.

is desired to control one or two incandescent lamps which are inaccessible, and which do not require a five or ten-ampere switch. It is neat in design and matches the company's standard sockets and receptacles.

PUSH-BUTTON PENDANT SWITCH.

The pendant push-button switch is most useful in connection with temporary or permanent installations of incandescent or multiple arc lamps. It is also adapted for use with fan motors, as it locates the control of motors at the most advantage-

BABY KNIFE SWITCH.

ous points, regardless of the accessibility of the motor.

In both types of switch the contact surfaces are of ample size, and the mechanism is dependable. The circuit of the push-button switch is closed by pressing a button at the bottom of the switch, and opened by pressing the release button at the side.

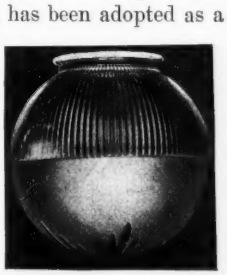
The key switch operates on the same principle as a standard key socket.

The standard finish of all the company's pendant switches is polished brass.

Another specialty in switches which the company has recently placed on the market is the double-pole, fifteen-ampere, 125-volt baby knife switch shown herewith. This switch follows the design of the large punched clip switches, and is neat, durable and compact.

A New Holophane-Pagoda Ball.

The new Syracuse (N. Y.) court house, upon which will be expended something like $1,000,000, and which will contain every modern advantage known to the architect, will exemplify, it is claimed, the latest ideas on the subject of illuminating engineering. The engineers and architects in charge of the building have determined to utilize to the fullest extent the advantages of economy which may be obtained through modern lighting methods. It is interesting to note that the new Holophane-Pagoda ball, which has recently attracted much attention among architects and engineers, has been adopted as a standard



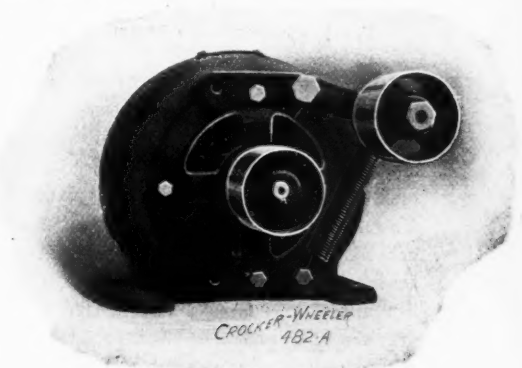
HOLOPHANE-PAGODA BALL.

in six-inch, seven-inch and eight-inch sizes, no less than 900 of these being used on the decorative chandeliers. In cases where a larger ball was necessary, and where, owing to the fact that the Holophane-Pagoda balls were not manufactured in such sizes, a ground glass ball has been specified. For what might be called the "useful light" fixtures, Pagoda reflectors have been specified in each case, over 2,000 being employed. About 1,000 Pagoda balls are to be furnished with a handsome cut-glass star on the bottom, which will add greatly to their appearance without detracting from the illuminating value. The accompanying illustration is a reproduction of the standard six-inch Holophane-Pagoda ball.

Automatic Belt-Tightening Idler.

The accompanying illustration shows a newly designed belt-tightening attachment for the standard Crocker-Wheeler form L motor manufactured by the Crocker-Wheeler Company, Ampere, N. J. This tightener may be used wherever the limited centre distances between pulleys require an increased belt contact on the pulley surfaces.

The device is so designed and supplied to the customer that it may be attached at any time to any form L motor having a rear end shield. Its principal parts are



AUTOMATIC BELT-TIGHTENING IDLER.

the idler pulley, arm and block, spring-stud and block, and the adjustable spring and hook for connecting them.

The idler pulley and arm are pivoted on a stud which may be screwed into either of the two tapped holes in the block. The block itself may be attached to the motor in any of the four positions by a special screw replacing any one of the four machine screws holding the rear shield to the motor frame. Eight locations are thus afforded for the pivot of the idler arm.

It is a comparatively simple matter to judge as to which one of the locations should be used for any given arrangement of the belt, bearing in mind, of course, that the idler pulley must rest on the slack side of the belt. The stud to which the spring is anchored may, in like manner, be screwed into either one of two holes in the block, similar to the one just described, and this block may be mounted in any one of the three remaining positions around the rear shield. The position which should be used will depend upon the way the idler pulley rests on the belt.

When the parts are in position, further adjustment may be obtained by screwing the hook in and out of the spring before hooking on to the attachment. Adjustment for stretch of belt may also be readily made in this manner at any time.

A New Electrical Measuring Instrument.

It has been the practice to support the moving system of measuring instruments of the permanent-magnet, moving-coil type, when applied to switchboard and similar work, upon hardened steel pivots in jeweled bearings, and to conduct the

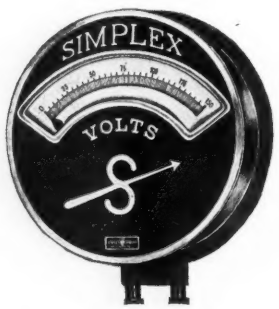


FIG. 1.—SWITCHBOARD INSTRUMENT.

current into and out of the moving coil by means of spiral springs.

To remedy several defects alleged against this type of instrument, the Simplex Company, 60 Nassau street, Newark, N. J., has brought out a permanent magnet suspension instrument which is entirely free from these defects. Fig. 1 illustrates the common switchboard form of this type and Fig. 2 illustrates the double portable instrument. The general internal mechanism is shown in Fig. 3 and Fig. 4, of which the former is a top view looking down on the instrument scale (the case and cover being removed), and

FIG. 2.—DOUBLE PORTABLE INSTRUMENT.

the latter is a section somewhat enlarged on AB of Fig. 3.

By referring to these figures it will be noted that the instrument involves a horseshoe permanent magnet having four flat soft-iron pole-pieces and a flat disc soft-iron core. The moving system consists of a flat rectangular coil wound on a damping frame, supported above and below by straight band conducting filaments which are attached through a yielding support to insulated bridge-pieces. The pole-pieces, core, bridge-pieces and scale are all supported by a one-piece structure, rendering their mutual alignment permanent. The pole-pieces fit tightly into recessed slots in the magnet ends, and perfect magnetic contact results. The magnet is secured in place by cotter pins tightly driven into the pole-pieces.

The filaments, which serve the triple purpose of supports, electrical conductors and retarding springs, are made

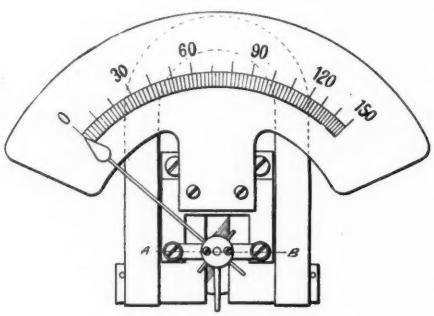


FIG. 3.—CASE AND COVER REMOVED.

from a highly resilient bronze alloy of good conductivity, low temperature coefficient and high tensile strength. They are non-oxidizable and so proportioned that they radiate easily the heat generated in them at maximum reading.

The yielding support mentioned above is an important feature of the device, as

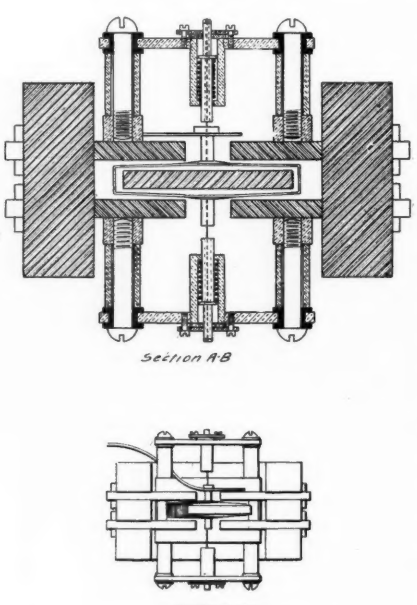


FIG. 4.—SECTIONAL VIEW AND PROJECTION.

it protects the moving system from damage by jar or continued vibration, and corrects for the change in the length of the filament due to change in temperature or angular movement of the moving coil.

The pull upon the filament is so regulated that the latter is kept perfectly taut, and the moving system being balanced, the instrument may be operated in any position. The flat moving coil with its particular arrangement of magnetic-air gaps has its entire coil surface active, thus allowing a lighter coil than would otherwise be necessary.

The magnet is assembled with its pole-pieces and core before ageing, and the latter is not again removed, the front arrangement of the parts being such that the moving coil may be readily assembled or removed without disturbing any of the other parts. The magnet is made up of a high-grade Swedish magnet steel, notable for its strength and permanence, and is thoroughly treated and aged by special processes.

In operation the instrument behaves like a pivot and jewel-supported moving coil instrument, with the absence of friction. It may be subjected, the maker states, to unusually severe jars or vibration without damage and will operate perfectly under all atmospheric conditions.

Electrolytic Production of Oxygen and Hydrogen.

A new electrolyzer brought out by the Oerlikon Company, of Zürich, Switzerland, for decomposing water into oxygen and hydrogen is described in the *Electrical Engineer* (London), September 15. This electrolyzer is said to avoid many of the disadvantages of earlier types. Cast-iron electrodes are used, and between them are located resistant diaphragms, which act as insulators. The cells are connected in series, and a ten per cent solution of potassium carbonate is used as the electrolyte. The gases pass through openings in the plates into two separate pipes, and, together with a part of the solution, are carried into the separators, where the gas is freed from the water, which flows back into the apparatus through a common pipe. It is said that gas can be evolved under a pressure of 2.5 metres of water. The oxygen obtained is ninety-nine per cent pure, and the hydrogen, ninety-nine per cent. The pressure required is about 2.7 volts per chamber, but after being in use for some time, the temperature rises about sixty degrees centigrade, and the voltage falls to 2.3. The only attention required during operation is a renewal of the water. Four kilowatt-hours are required to produce one cubic metre of gas. At one cent per kilowatt-hour, one cubic metre of gas, consisting of one-third oxygen and two-thirds hydrogen, costs four cents.

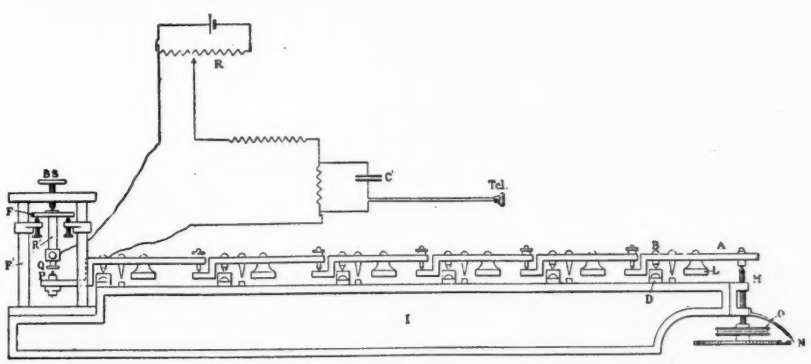
An Electric Micrometer.

At a recent meeting of the Royal Society, of London, Dr. P. E. Shaw presented a paper describing an electric micrometer adapted to measure exceedingly small distances. The following abstract of this paper was given in *Nature*, September 14:

There is no finality in experimental measurement. In physics it is a common experience for a present-day worker, with better appliances and a wider horizon than his forerunners, to surpass all previous experimental work in accuracy. As knowledge increases it becomes more minutely exact, and nowadays the physicist has often to measure lengths much less than anything visible in any microscope.

There are various means of measuring small distances. We will take them in order, commencing with the least sensitive: (1) The unaided eye can not perceive much less than 1/10 millimetre. (2) With the aid of the microscope the eye can see as little as 1/5000 millimetre. (3) The measuring machine used for engineering gauges will detect differences of 1/8000 millimetre. (4) By using interference bands of light we can perceive movements of 1/100,000 millimetre. (5) In the optical lever a beam of light falls on a pivoted mirror; if a body push the mirror at a point very near the axis of that pivot the beam of light is deflected by a large angle. By this means a movement of the body by 1/400,000 millimetre may be detected. (6) The most modern and sensitive method, the electric micrometer, is due to Dr. P. E. Shaw, who produced it in 1900, and has improved it until he can now measure less than 1/2,000,000 millimetre. The nucleus of the apparatus is shown in the figure. A fine screw M has a graduated head N. The screw in rising pushes up the long arm of a lever pivoted at B. The short arm of the lever falls, and in so doing lets down the long arm of a second lever. This process is carried on through six levers, which all rest under their own weight on the blocks shown. The last lever carries a measuring point P, just above which is a measuring surface Q. If the joint leverage of the lever system be 2000/1, an upward movement of the screw point M by 1/1000 millimetre produces an upward movement of P by 1/2,000,000 millimetre.

As a simple example, suppose we wish to find the thermal coefficient of expansion of the rod R, we proceed thus: bring P and Q into contact. The screw M is worked up, while a telephone (Tel.), in the electric circuit shown, is on the observer's head. When P touches Q a circuit is completed, and the telephone sounds. Read the graduated disc N. Now lower the temperature of R by any desired amount, taking care that little or no heat reaches the pillars F′ or any part but R. R contracts, and by working screw M up the observer causes P to touch Q again; the telephone sounds, and N is again read. The expansibility can thus be found, when we know the movement of P and the change in temperature.



ELECTRIC MICROMETER.

The screw, the levers, and the frame F′ are all carried by a massive girder 1. The whole is surrounded by a box thickly wrapped in felt to minimize temperature changes, and is suspended by long rubber cords from the ceiling, to insulate the measuring apparatus from vibration.

The screw M is not touched by hand, but is worked by a pulley cord of rubber which passes from a hand pulley around pulley O. This is done to avoid the comparatively rough touch and tremor of the hand. There are many precautions as to shape, size, cleanliness, and other matters which must be observed.

The smallest measurements ever yet made, *viz.*, 1/2,000,000 millimetre, were in connection with the movements of a telephone diaphragm. The problem was to find what movement of the diaphragm produces a sound which is only just audible.

This is done as follows: place a telephone to the ear and pass through it a steady current. On stopping the current a sharp sound is heard in the telephone. Alter the strength of the current until when it is stopped the sound can only just be heard. Observe on a galvanometer the strength of that current (c). Next put the telephone in the electric micrometer in place of the rod R, pass the current (c), and measure the movement of the diaphragm in the usual way. This movement then produces a sound in the telephone which is just audible.

Another use of the instrument is to measure the sparking distance between two surfaces, the potential difference of which is known. The surfaces used are P, Q in the figure. Suppose the potential difference between these surfaces is very small, say 1/1000 volt. Find the contact position as above, and draw P away from Q. Now make the potential difference between P and Q equal to one volt. On making P approach Q the contact position has changed by an amount D. Thus the sparking distance for one volt is D (supposing the spark distance for 1/1000 volt is negligible). This is found to be about 1/100,000 millimetre.

In problems on the constitution and molecular properties of matter there are obvious possibilities before this apparatus, for by it we can bring two surfaces of any hard metal to molecular distance (or less) from one another, and keep them there while any desired physical change is produced in the surfaces or in the medium surrounding them.

The Annual Banquet of the Cutlers Company.

Mr. William F. Wagner, general manager of William Jessop & Sons, Limited, in the United States, together with Mr. Edward L. Hand, Philadelphia representative; Mr. E. W. Salisbury, of Warren, Salisbury & Nightingale, Providence agents; Mr. R. B. Ridgley, Detroit representative; and Mr. F. W. Babcock, of Providence, R. I., a member of the Standard Oil Company, sailed on the Cunard steamer Caronia on October 3 to attend the 282d annual gathering of the Cutlers Company, at the banquet in Sheffield, on October 12. On this occasion Mr. Sydney Jessop Robinson, managing director of William Jessop & Sons, Limited, will be installed as master cutler, a position of honor and social and commercial influence.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

MEXICAN LIGHT COMPANY'S PLANS—The shareholders of the Mexican Light and Power Company, at a special meeting held at the Bank of Montreal, Montreal, Canada, ratified the plan of the board of directors to increase the capital stock of the company from $12,000,000 to $16,000,000. The additional $4,000,000 will be used to secure control of two of the largest lighting companies in Mexico.

EXTENSIVE MERGER OF OHIO AND INDIANA LINES—It has been announced that a large number of the interurban electric railroads of Ohio and Indiana are being merged by Philadelphia capitalists. Two holding companies are to be formed—one in Ohio and one in Indiana. Hugh J. McGowan, president of the Indianapolis Terminal Traction Company, will be at the head of the Indiana holding company, and J. C. Schoepff, president of the Cincinnati Traction Company, will be at the head of the holding company for Ohio. Fifty million dollars is said to be involved.

ANIMAS POWER COMPANY INCORPORATED—Articles of incorporation of the Animas Power Company, Denver, Col., have been filed with a capital of $3,000,000. The incorporators are Leonard E. Curtis, O. B. Willcox and Henry Hine. The powers of the company are to promote and own water rights, to sell water, to manufacture power and sell it, to build ditches, dams, and telephone and telegraph lines. The directors for the first year are Henry Janeson, S. Z. Mitchell, B. Frank Schmid, John H. Holliday, Leonard E. Curtis, Henry Hine, Irving W. Bonbright, O. B. Willcox and J. Arthur Campbell.

NEW YORK CITY EXPERIMENTAL MUNICIPAL LIGHT PLANT—New York city will have its first municipal light station completed at an early date, if the present rate of progress continues. The station is building on Delancey street, under the approach to the Williamsburg bridge. With the lighting station, the city is building an incinerator. The fuel to be used will be the quantities of waste paper and other rubbish gathered by the street cleaning department. The light plant will have a capacity of about 400 horse-power, and will light the Williamsburg bridge. It is possible that a surplus will be available, and this will be used to illuminate some of the schoolhouses which have been built at various places in the vicinity.

INDEPENDENT TELEPHONE COMPANIES' MERGER—The organization has been announced of the United States Independent Telephone Company, the purpose of which is to unite in connecting systems the various independent plants throughout the country. Thomas W. Finucane is the president of the new company. Among the directors are Adolphus Busch, Walter B. Duffy, George Eastman, August Gehner, Robert C. Hall, William H. Page, Hendrick S. Holden and Hiram W. Sibley. President Finucane is quoted as saying that the company possesses franchises which will allow the installation of a plant with a present capacity of 225,000 telephones, and an ultimate capacity of 750,000 telephones, in New York city and the tributary districts which environ it. The company has authorized its collateral mortgage of $25,000,000, and the underlying securities will comprise the control, it is said, of the Stromberg-Carlson Telephone Manufacturing Company, of Rochester, N. Y. The company also controls the New York Independent Company. The auditing advisers will be Haskins & Sells, of New York.

THE HOLLAND ELECTRIC ROAD—The Holland-American Construction Company, a brief mention of which was given last week, has been incorporated and will begin building, at an early date, a railroad from the German frontier to the North Sea. It has been stated that the railroad will cover some 115 miles. It is understood, however, that the present intentions are to develop about forty-two miles of road. There is opportunity for making further extensions when this shall be deemed advisable. Freight and passengers will be carried, and although it has been stated that a speed of sixty miles per hour would be adopted, it is unlikely that so high a speed will be inaugurated. The board of directors includes the following: George C. Smith, vice-president of the Security Investment Company, Pittsburg, Pa.; Walter D. Updegraff, of the same company; Newcomb Carlton, fourth vice-president of the Westinghouse Electric and Manufacturing Company; Joseph H. Lukach, a director of the British Westinghouse Electric and Manufacturing Company, Limited; John F. Alden, at one time connected with the American Bridge Company. Mr. Alden, J. G. Kaelber, Charles H. Palmer and John H. Beckley have sailed for Europe. It is understood that the enterprise will represent an expenditure of not far from $5,000,000.

HELENA LIGHT AND RAILWAY COMPANY—The Helena Light and Railway Company is the new name for the Helena Light and Traction Company, Helena, Mont., a certificate of incorporation having been filed with a capital stock of $1,500,000. The new concern is to have its main office at Hartford, Ct., and is given authority to purchase, lease, construct or otherwise acquire and operate by electrical or other power, street and interurban railways for the transportation of passengers, mail, express, merchandise or other freight, and to purchase or otherwise acquire lines; to operate, invest in or control any amusement or recreation park or other enterprise designed to develop or increase the business or patronage of any railway operated or controlled by the company. Authority is also given the company to manufacture and supply electricity, illuminating and other gases, and steam for light, heat and power; to appropriate and supply water and water power and utilize it for any purpose; to generate and dispose of power and energy in any form, and to purchase and develop mines. The incorporators are Lewis Sperry, South Windsor, Ct.; Harry W. Reynolds, East Haddam, Ct., and Warren B. Johnson, Enfield, Ct. Mr. Sperry is president, and Mr. Johnson, secretary, of the company.

EDUCATIONAL.

ARMOUR INSTITUTE OF TECHNOLOGY—The Armour Institute of Technology, Twenty-third and Armour avenues, Chicago, Ill., is offering evening classes for the session of 1905-1906 in mechanical, electrical, telephone, civil, chemical and fire-protection engineering, with drawing, practical shop work and mathematics.

FOUNDER'S DAY AT LEHIGH UNIVERSITY—Lehigh University, Bethlehem, Pa., held on October 12 the twenty-sixth celebration of Founder's Day. The Founder's Day address was delivered by the Hon. Hampton L. Carson, attorney-general of Pennsylvania, Dr. Henry Sturgis Drinker was inaugurated as president of the university, the installation address being delivered by Mr. Robert H. Sayre, president of the board of trustees. The new president was greeted, on behalf of the alumni, by Mr. Frank P. Howe. Among the ceremonies was the turning the sod for Drown Hall.

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES—The prospectus for 1905-1906 of the Brooklyn Institute of Arts and Sciences has been issued. Mr. William D. Sargent is president, and Mr. Frederick V. Henshaw, secretary of the department of electricity. The following course has been outlined for the department of electricity: (1) a series of illustrated lectures on electrical engineering; (2) a course of six illustrated lectures on electrodynamics or the relation of magnetism to electricity; (3) a course of six illustrated lectures on physical chemistry; (4) a course of six illustrated lectures on electrolytic dissociation and deposition of metals by the electric current; (5) a course of six illustrated lectures on the elements of magnetism and electricity; (6) visits to important electrical power stations and works. The collection of electrical apparatus belonging to the department has been transferred to the museum building, and important additions have been made to it during the past few weeks.

TELEPHONE AND TELEGRAPH.

HAZLETON, PA.—The Bell Telephone Company has begun work on an automatic exchange in McAdoo.

WEST UNION, IOWA—A new farmers' line, running southeast of West Union, has been placed in operation.

PHILADELPHIA, PA.—A telephone company has opened an exchange with twenty subscribers at Fleetwood, Pa.

SARATOGA SPRINGS, N. Y.—The Commercial Union Telephone Company is extending its line to Victory Mills.

BRIDGETON, N. J.—Williamstown's new rural telephone system now includes nearly one hundred subscribers, the circuits extending to Sicklerville, Cross Keys, Turnerville, Janvier and Cecil.

OGDEN, UTAH—The new lines of the Independent Telephone Company are now constructed as far as Riverdale and are being continued to Roy, where a number of instruments are being installed.

OSWEGO, N. Y.—The Ontario Telephone Company has awarded the contract for erecting its new building to A. Paine & Son, the contract price being $20,000. The structure is to be thoroughly modern.

HATTIESBURG, MISS.—The Jones-Winters Telephone Syndicate, which was recently granted a franchise for an underground telephone system in Hattiesburg, has filed with the city council its acceptances of the franchise, and work on the system will commence at once.

RICHMOND, VA.—The Spotsylvania Telephone Company will soon extend its line from Massaponax to Summit station, on the Richmond, Fredericksburg & Potomac Railroad. At the last meeting of the stockholders of the company, George W. Perry was chosen president in the place of James P. Turnley, who declined reelection.

KEYSER, W. VA.—The Piedmont & Keyser Telephone Company has sold its entire system to the Chesapeake & Potomac Telephone Company, of Baltimore, for the sum of $20,500 cash. This company has an important system, covering several counties in West Virginia and territory in Maryland adjoining. The Chesapeake & Potomac company has now under way a line from Cumberland to Oakland, Md.

GREENFIELD, MASS.—The Heath Telephone Company has purchased all the property of the Rowe Telephone Association, the change of management to go into effect October 1. A number of new subscribers will be connected with the system in Rowe as soon as the change is made. The Heath company is making extensions in Colrain, Buckland, Charlemont and Hawley, and by October 1 its subscribers will probably exceed 750.

NEW HAVEN, CT.—The American Telephone and Telegraph Company has a force of men laying underground wires for its long-distance system in the town of Orange. All the needed rights of way have been secured. The Orange section of the conduit will be practically six miles long, and it will contain ninety wires. When the Orange contract is finished the company's long-distance wires between New Haven and New York will all be underground.

WINONA, MINN.—The Western Wisconsin Telephone Company has started work on the new Stevenstown telephone line and will build twelve miles this fall, opening a new territory between Galesville and La Crosse County, connecting with the long-distance lines of the Winona Telephone Company. The Western Wisconsin company has put up over a hundred miles of line this year. The Winona Telephone Company is rebuilding its lines along Washington and Huff streets leading into Winona from the south.

TRENTON, N. J.—Plans are under way for a reorganization of the Inter-State Telephone Company, which has a local system at Trenton, N. J., and long-distance lines reaching to other points in New Jersey and Pennsylvania. The company has outstanding bonds of $1,913,000; bonds sold and to be issued, $400,000; interest due and floating debts, $200,000; total bonds and debts, $2,513,000. It is proposed to issue $1,000,000 five per cent first mortgage bonds, $4,000,000 general mortgage bonds and $600,000 in stock.

SEATTLE, WASH.—General Manager E. E. Webster, of the Independent Telephone Company, has signed $1,000,000 in debenture bonds, issued by the company, which have been sold. The money will be used in perfecting a long-distance system, covering every part of the northwest from Portland on the south to Vancouver and Victoria, British Columbia, on the north. The local company has perfected an arrangement with the Independent company at Portland, whereby it will be brought into the combination.

BELLEVUE, OHIO—A large telephone deal, which has been pending for some time, was consummated recently, when Frank A. Knapp, of Bellevue, purchased from local parties the controlling interest in the Local Telephone Company and the Bellevue Home Telephone Company. The Local Telephone Company operates in Huron and Crawford counties and has 4,200 telephones in use and over 200 miles of toll lines. It is understood that associated with Mr. Knapp are some of the strongest independent telephone interests in the state. The deal carries with it the control of telephone properties representing an investment of over $400,000.

NEW YORK, N. Y.—Following their reduction of rates in Manhattan and Brooklyn last spring and more recently in The Bronx, the New York Telephone Company and the New York & New Jersey Telephone Company announce a new schedule of discounts which became effective on October 1, 1905. The discount will be allowed on toll messages when contracted for in advance, sent from any subscriber's station in any exchange district of the city of New York (which includes all the boroughs) to all other stations in any other designated district in the city of New York. The subscriber may also select not more than three stations in the exchange district so designated, and all messages sent from them to his station will be subject to the discount, which is as follows: on a guarantee of twenty-five messages a month, ten per cent; fifty messages twenty per cent; 100, thirty per cent, and 200, forty per cent.

NEW MANUFACTURING AND CONSTRUCTING COMPANIES.

NEW YORK, N. Y.—The Rooney Electric Lamp Company has been incorporated with a capital of $50,000. The directors are J. J. Rooney, Scarsdale; F. J. Rooney, John Rooney, Brooklyn.

PORTLAND, ME.—Deane & Company has been incorporated to deal in electrical supplies, etc., with a capital of $25,000. Frank G. Deane, of Cheltenham, Pa., is president, and Charles H. Tolman, Portland, Me., is treasurer.

BOSTON, MASS.—The Ajax Electric Manufacturing Company has been organized to deal in electrical goods, with a capital of $5,000. The president of the company is Charles C. Walker, Boston, and the treasurer Frederick E. Smith, Boston.

SPRINGFIELD, OHIO—Articles of incorporation have been issued to the Selective Telephone Manufacturing Company. The company is capitalized at $60,000. Its members are James M. Brailey, of Toledo, and C. D. Juvenal and William M. Bruce, Jr., of Springfield.

SOUTH BERWICK, ME.—The Standard Magnet Wire Company has been formed to manufacture and deal in insulated wire for interior telephone service. The capital is $25,000, and the officers are: president, William Thompson, of South Berwick; treasurer, William Thompson.

WEEHAWKEN, N. J.—The Schmidt-Wilckes Company has been incorporated to manufacture telephones, electrical appliances and electrical machinery. The capital is $100,000, and the incorporators are Lambert Schmidt, Weehawken, N. J.; Felix Wilckes, Ferdinand Wilckes, Brooklyn, N. Y.

ST. LOUIS, MO.—The Woolley Electric Company has filed papers of incorporation in the recorder's office and will at once proceed to manufacture electrical devices of all kinds. The officers of the company are Fred Essen, president; E. C. Hencken, vice-president, and W. D. Woolley, secretary and treasurer; and it is operating with a capital of $25,000.

ALBANY, N. Y.—The Holland-American Construction Company, of Rochester, has been incorporated to construct railways, power and electric plants, canals and other public works. The capital is $1,000,000, and the directors are: Newcomb Carlton, New York; George C. Smith and Walter D. Updegraff, Pittsburg, Pa.; Joseph H. Lukach, London, England; John H. Beckley, Chas. H. Palmer, J. George Kaelber, John F. Alden and George C. Ruell, of Rochester.

ELECTRIC LIGHTING.

MINNEAPOLIS, MINN.—An electric light plant will be established at Mahnomen.

ALBANY, N. Y.—The Chatham Electric Light Company has extended its line to Ghent.

BANGOR, ME.—Charles E. Capen has been granted a franchise for an electric light and power plant.

ROCKVILLE, IND.—T. R. Calvert has been awarded the contract for the electric light plant at Dana.

PAULS VALLEY, I. T.—St. Louis capitalists have purchased the electric light plant and will at once enlarge it.

PHILADELPHIA, PA.—Myerstown is to have electric lights, to be supplied by feed wires run from Lebanon.

BOSTON, MASS.—The Dexter Electric Light Company, of Dexter, Me., has sold its plant and business to N. Curtis Fletcher, of Boston.

AUBURN, CAL.—At a meeting of the city trustees it was decided to sell the old gasoline street lights and install electric arc lights.

GREENSBORO, N. C.—The Greensboro Electric Company has improvements to its plant underway, requiring the expenditure of $50,000.

ST. CATHERINES, ONTARIO—The Cataract Power Company has been granted a twenty-five-year franchise by the St. Catherines city council.

CLINTON, IOWA—The Clinton Gas, Light and Coke Company, at an expense of more than $30,000, will reequip its entire electric lighting plant.

DETROIT, MICH.—The Detroit Edison Company has acquired the Grosse-Pointe Farms electric lighting plant, which supplies a suburb of Detroit.

LANSING, MICH.—The Piatt Power Company, of Lansing, has purchased the water privilege at Grand Ledge and will erect a power-house there.

VINTON, IOWA—The Zinn Electric Light and Power Company, of Oxford, has purchased the electric light plant at Anamosa and will operate the same.

PATERSON, N. J.—The Rockland Electric Company is running a new line between Mahwah and Monroe, which will take in the mountain road to Ramapo.

BUFFALO, N. Y.—The Niagara, Lockport & Ontario Power Company has been granted a franchise by the town board of Newstead for a transmission line through that town.

OROVILLE, CAL.—The Oro Light, Water and Power Company is making arrangements for the immediate construction of a power plant near Pentz and a pole line to Oroville.

MAYFIELD, CAL.—The municipal electric light system has been abandoned and the town trustees are preparing to contract with a San Jose concern to furnish power for street illumination.

MOUNT STERLING, KY.—Cincinnati capitalists have closed a contract with J. W. Riley, of Morehead, to erect a modern electric light plant in that city at once. The plant will cost $15,000.

BINGHAMTON, N. Y.—The trustees of the village of Port Dickinson have closed a contract with the Binghamton Light, Heat and Power Company for electric light service for the village streets.

ELLICOTT CITY, MD.—Arrangements have been made between the Howard County commissioners and the Patapsco Electric Light and Manufacturing Company for the placing of lights in Elkridge.

SIOUX FALLS, S. D.—The Sioux Falls city council has decided to make a contract with the Sioux Falls Electric Light and Power Company for furnishing the power necessary for street lighting.

MEREDITH, N. H.—The directors of the newly organized Meredith Electric Light Company, residents of Providence, R. I., have decided to increase the capital stock of the company from $9,000 to $16,000, and to change the system to an alternating one. The power-house at Meredith will be done away with, and power brought from Laconia.

ROCKVILLE, MD.—At a special meeting of the mayor and council of Rockville a contract was entered into with Anderson Offutt, H. Worthington Talbott and David M. Munro for the rehabilitation of the lighting plant.

HAMILTON, OHIO—The board of directors of the Hamilton Gas and Electric Light Company has passed a resolution ratifying the expenditure of $250,000 in improvements on the electric light plant and the Otto Coke Works.

BIRDSBORO, PA.—The Birdsboro Electric Light and Power Company will erect a power plant along the Schuylkill road, and secure the power for running its dynamos from the upper level of the canal by turbine water-wheels.

SALEM, ILL.—The village board of Odin has granted a twenty-year franchise to the Odin Coal Company, for the operation of an electric light plant, and the village has contracted for forty arc lights for street lighting at fifty dollars each.

SHELBYVILLE, IND.—The Shelbyville electric light and water plant has been sold to C. F. Streeter, of New York city, the consideration being $36,000. It is given out that F. M. Knuckles, who was receiver of the plant, will continue in charge.

FISHER, ILL.—The Fisher village board of trustees has awarded to the Wardlow Electric Lighting Company a franchise, which provides that the company shall light the streets of the village with twelve arc lights of 1,200 candle-power each at $50 per month.

PHILADELPHIA, PA.—The Tremont & Pine Grove Electric Light and Power Company has sold its plant to Philadelphia, Williamsport and Lancaster capitalists for $30,000. The new owners will extend the lighting facilities to Donaldson on the north and to Pine Grove, south of Tremont. It is also proposed to connect these towns by trolley.

EXETER, N. H.—The deed conveying the plant, business, good will, etc., of the Frank Jones Electric Company to the Rockingham Light and Power Company, a subsidiary company of the New Hampshire Traction Company, has been recorded. This company operated in Portsmouth, Newcastle and Rye, and the deed was executed by the trustees of the Jones estate.

GREELEY, COL.—The Home Electric Light and Power Company will increase its capitalization from $4,500 to $50,000. The company, which is composed of professors in the State Normal school, and others, has conducted a small electric light plant in the vicinity of the State Normal school so successfully that it will enlarge the plant to supply the entire town. A franchise was granted to it recently.

TORONTO, ONTARIO—The construction of the power plant at Kaministiquia falls, near Fort William, Ontario, by the company organized by C. R. Hosmer, H. S. Holt and F. W. Thompson will be rushed as rapidly as possible. The company has let contracts to the Canadian General Electric Company for the generators, exciters, switchboards, etc., the total cost being, it is understood, in the neighborhood of $200,000.

SANTA FE, N. M.—The city council of Silver City has entered into a contract with the New Mexico Light, Heat and Power Company for the furnishing of lights to the city by said company for a period of two years, with the privilege of renewing the contract from year to year for a period of five years from date. The price for all lights now installed is to be ninety cents per light per month, and $1.50 per light per month for any additional lights the city may desire.

ST. LOUIS, MO.—Paul D. Cable, president of the General Service and Development Company, of Webster Groves, has been granted a franchise by the county court to operate the electric business of the West St. Louis Water and Light Company, which he recently purchased. A clause which forces the company to extend its service 1,000 feet for each consumer was added. Mr. Cable stated that the company would proceed at once to string wires throughout the eastern and southern parts of the county.

ELECTRIC RAILWAYS.

POTOMAC, ILL.—The Danville-Urbana-Champaign Railway Company has been awarded a fifty-year franchise over the highway between Catlin and Fairmount.

INDIANAPOLIS, IND.—The work of clearing the right of way for the Muncie-Newcastle spur of the Indianapolis, Newcastle & Toledo traction line has been started.

INDIANAPOLIS, IND.—The city council of Brazil has granted the Indianapolis & Ohio Valley Traction Company a franchise to enter the city for a term of fifty years.

ST. JOSEPH, MICH.—The proposed interurban line of the South Bend & Southern Michigan Railway Company, between Niles and St. Joseph, will be completed by next spring.

HOLYOKE, MASS.—The Holyoke board of aldermen has granted the Holyoke Street Railway Company's petition to act as a common carrier on all its lines within the city limits.

ALEXANDRIA, LA.—Thomas Hamilton, of Mobile, superintendent of construction of the Alexandria electric street-car line, is making arrangements to commence at once the building of the line.

HOPKINSVILLE, KY.—The franchise for the building and operation of an electric street railway system and electric light plant in Hopkinsville for twenty years has been purchased by John H. Bell, Jr., of Hopkinsville.

PORTLAND, ORE.—Orders have been placed in New York by the Oregon Water Power and Railway Company for machinery, costing $150,000, to be installed in the new electric power plant under construction at Cazadero.

SUNBURY, PA.—The Sunbury council has granted the right of way over Market street, east of the Pennsylvania Railroad tracks, and other principal thoroughfares in the borough to the Sunbury & Northumberland Electric Street Railway Company.

ALLENTOWN, PA.—Congressman G. A. Schneebeli, with Northampton and Monroe County capitalists, has reorganized the Stroudsburg & Wind Gap Electric Railway Company. Announcement is made that a line, fourteen miles in length, will be built at once.

WATERVLIET, MICH.—At a meeting of the Watervliet village council a franchise was granted to W. A. Baker for an electric road to Paw Paw lake. The grading will be completed this fall and the rails laid in the spring. Paw Paw lake is a growing summer resort, twelve miles from Benton Harbor.

DUBOIS, PA.—The Dubois Traction Company has authorized the extension of the Dubois street railway southward this fall to Sykesville, seven miles distant. At Sykesville a junction with the Jefferson Traction Company's lines will be effected, providing for uninterrupted trolley service between Dubois, Reynoldsville and Punxsutawney.

MANCHESTER, N. H.—At the annual meeting of the Manchester Traction, Light and Power Company the following board of directors was chosen: Walter M. Parker, Roger G. Sullivan, Harry E. Parker, J. Brodie Smith, Charles M. Floyd, Manchester; W. A. Tucker, S. Read Anthony, P. L. Saltonstall, Billings P. Learned, George H. Hood, Robert Hallowell and Stillman F. Kelly, of Boston.

WASHINGTON, PA.—The Washington, Waynesburg & Monongahela Railway Company has been organized by Waynesburg capitalists to build a trolley line between Washington and Waynesburg. The lines will pass through the towns of Swart, Dunns Station, Deerlick and Sycamore and the townships of Franklin, Washington and Morris in Greene, and Morris and Franklin in Washington County.

BARTLESVILLE, I. T.—A company has been formed to build and operate an electric line between Bartlesville and Dewey, I. T., which contemplates connection with Coffeyville, there connecting with a network of interurban electric lines that will join most of the towns of the Kansas oil belt. The promoters of the company are William Johnson, J. J. Curl, W. M. Higgins, Dr. Woodring, of Bartlesville; W. M. Speck and Mr. Woodson, of Dewey; John Overfield, of Independence, and W. T. Hutchins, of Muskogee.

ST. LOUIS, MO.—A deed of trust from the St. Louis, Vandalia, Terre Haute & Eastern Traction Company to the Chicago Title and Trust Company and William C. Niblack has been filed in the recorder's office at Belleville. It is for $6,000,000, to secure the loan of funds with which to construct an electric line from East St. Louis to Terre Haute, Ind.

DES MOINES, IOWA—The Interurban Railway Company is negotiating to extend its Colfax line to Newton by building three miles from its present terminus to Goddard a new station on the Newton & Northwestern, and thence into Newton on the Newton & Northwestern line. It is very probable that this plan will be carried out and electric cars be in operation between Des Moines and Newton by January 1.

TELLURIDE, COL.—The board of county commissioners of San Miguel County has granted a franchise for an electric road into Marshall and Savage basins, following the granting of a franchise by the city council for an electric road to run through the city of Telluride. The promoters propose to reimburse the county to the extent of $35,000, the amount spent in building the county road into Marshall and Savage basins.

HAMILTON, OHIO—At the annual meeting of the Cincinnati, Dayton & Toledo Traction Company stockholders the following directors and officers were elected: George B. Cox, of Cincinnati, president; C. C. Richardson, first vice-president; J. B. Foraker, Jr., of Cincinnati, second vice-president; F. R. Williams, secretary and treasurer; W. C. Shepherd, general counsel; L. A. Ireton, W. E. Hutton, Peter Schwab and O. V. Parrish, directors.

ROCHESTER, N. Y.—Bonds to the amount of $1,000,000 have been signed by the vice-president of the Buffalo, Lockport & Rochester Electric Railroad Company, the issue having been authorized by the state railroad commission. Some work has been done on this road in the vicinity of Spencerport, and the indications are that its construction will be rapidly pushed. The road will follow the falls branch of the Central between Rochester and Buffalo.

ALTOONA, PA.—A mortgage for $500,000 in favor of the Real Estate Title and Trust Company against the Southern Traction Company, which, backed by Pittsburg capital, is to build a trolley line from Altoona to Bedford, has been placed on record in Blair County. President Frank G. Patterson, of Pittsburg, states that about half the stock of the company has been subscribed for, and that work on the road will be started this fall.

CHATTANOOGA, TENN.—Work will begin shortly on the construction of the Tennessee & Georgia Terminal Railway. The objective point of this road at present is Catoosa Springs, Ga., which will give the road connection with the Western & Atlantic road. After the road is completed to Ringgold it will be extended fifteen or twenty miles farther to connect with the Louisville & Nashville, running between Knoxville and Atlanta. This will give direct connection with Chattanooga and the Ducktown copper mining regions.

BRAZIL, IND.—The county commissioners have granted franchises to two traction companies—one the Indianapolis & Ohio Valley Traction Company, for the construction of an electric line through Clay County, touching the towns of Bowling Green, Center Point, Patricksburg and Hoosierville. It is proposed to extend the road to Bloomington, where it is to connect with the main line from Indianapolis. The other franchise was granted to the Wabash Valley Traction Company. The road is to pass through the southern part of Clay County, touching Clay City, Saline City and Cory. Both franchises are for fifty years.

BURLINGTON, VT.—It is now assured that the electric road connecting Rutland and Fair Haven, with a branch line to Lake Bomoseen, will be extended to Whitehall, N. Y. There has been a delay in the decision to construct the extension because of the gulch near Fair Haven that will have to be bridged. The directors have secured the necessary money to do the work, and the line will be in operation within another year. The surveys are already completed, and rights of way have been secured. The line will extend into a country rich in marble and slate deposits, and considerable attention will be paid to freight traffic. The road will also connect with the Champlain canal.

NEW INCORPORATIONS.

FRANKFORT, KY.—Goreing Telephone Company. $600.

CORAOPOLIS, PA.—Coraopolis Fuel and Light Company. $50,000.

AUSTIN, TEX.—Citizens' Electric Light and Power Company. Increased to $10,000.

CHAMPAIGN, ILL.—Illinois Traction Company. Increased from $5,500,000 to $7,500,000.

SYCAMORE, ILL.—De Kalb County Telephone Company. Increased from $100,000 to $150,000.

AUSTIN, TEX.—Texas-Mexican Electric Light and Power Company. Increased from $20,000 to $40,000.

ATCHISON, KAN.—Atchison Railway, Light and Power Company. Increased from $300,000 to $900,000.

ALBANY, N. Y.—Ashville & Panama Telephone and Telegraph Company. Increased from $15,000 to $25,000.

BIRMINGHAM, ALA.—Birmingham Electric Company. $5,000. Directors: C. J. Martin, D. A. Hunt and A. A. Hunt.

DENVER, COL.—Stevison Electric Company, Pueblo. $5,000. Incorporators: W. F. Stevison, M. Stevison and F. A. Blakeley.

DARLINGTON, S. C.—The Clinton Telephone Company. $25,000. Directors: L. S. Welling, N. L. Harrel, W. M. Haynesworth and W. D. Coggeshall.

CINCINNATI, OHIO—Municipal Light, Power and Fuel Company. $200,000. Incorporators: Harvey Myers, James H. Young and B. Bramlage.

STERLING, ILL.—Morrison Electric Lighting Company. Changed to Morrison Gas and Electric Company, and capital increased from $20,000 to $60,000.

COLUMBIA, S. C.—Georgetown Traction Company. $50,000. Incorporators: J. B. Steele, W. W. Taylor, E. W. Kaminski, W. H. Andrews and L. Monzon.

NORWALK, OHIO—Plymouth & Shelby Traction Company, Norwalk. $200,000. Incorporators: B. B. Avery, Sherman Culp, G. L. Rebman, Frank L. Scott, Sterling Parks.

HARTWOOD, VA.—Hartwood & Fredericksburg Telephone Company. $4,000. Officers: D. J. Shopoff, president; C. J. Henry, vice-president; P. W. Irvin, secretary and treasurer.

NEW HAVEN, CT.—The Amsterdam Corporation, of New Haven. To manufacture and sell electricity, etc. $10,000. Incorporators: Louis B. Grant, Ashley T. Cole and William J. Bagnell.

DANBURY, CT.—The Helena Light and Railway Company. $1,500,000. Incorporators: Lewis Sperry, of Hartford; W. B. Johnson, of Enfield, and Henry W. Reynolds, of East Haddam.

BALTIMORE, MD.—South Cumberland Electric Railway Company. $30,000. Directors: William E. Walsh, Peter J. Seaver, Harry E. Webber, Robert H. Gordon, David A. Robb, Ferdinand Williams.

CHAMBERSBURG, PA.—Hagerstown & Waynesboro Street Railway Company, of Waynesboro. $25,000. Directors: J. A. Strite, Chambersburg; Jacob S. Lesher, William T. Omwake, Waynesboro; John W. Feldman, Hagerstown; Roderick Clarey, Cumberland.

LITTLE ROCK, ARK.—Mercantile Telephone Company, of New Castle, St. Francis County. $17,000. Incorporators: F. J. McDougal, president; W. J. Dillon, vice-president; E. L. Horton, secretary and treasurer. To construct a telephone line from Forrest City to New Castle.

INDIANAPOLIS, IND.—Bluffton & Marion Construction Company, Bluffton. To construct an interurban line between the two points named. $100,000. Directors: L. C. Davenport, H. C. Arnold, L. A. Williamson, W. A. Kunkel, G. Max Hoffman, J. Wood Wilson, S. Bender, L. C. Justus and T. C. McReynolds.

SANDUSKY, OHIO—Sandusky, Fremont & Tiffin Traction Company; $100,000; incorporators: Charles Thomson, W. H. Gilcher, John G. Dorn, H. M. Daugherty and D. B. Sharp. Tiffin & Sandusky Construction Company; to build above road; $25,000; incorporators: J. T. Adams, J. E. Todd, F. R. Chapman, John T. Carding and J. H. Ross.

OROVILLE, CAL.—Oro Water, Light and Power Company. To deal in water rights and privileges; to manufacture and generate power, electric power and electric energy, and to sell and dispose of same; to manufacture and sell gas, etc. $3,500,000. Directors: J. A. Kretschmer, R. C. Medcraft, J. Alexander, L. A. Redinger, A. Harvey.

AUSTIN, TEX.—Fort Worth & Mineral Wells Electric Railway Company. For the purpose of building an interurban electric railway between Fort Worth and Mineral Wells, a distance of about sixty miles. $250,000. Directors: Cicero Smith, D. M. Howard, H. N. Frost, E. J. Waldrow and Albert Stevenson, all of Mineral Wells.

JEFFERSON CITY, MO.—Central Railway Company, of Kansas City. $1,500,000. To build a road fifty miles long to extend from Miami, in Saline County, to Sedalia, in Pettis County. Stockholders: W. E. McCulley, Macon; W. S. Roberts, Chicago; T. J O'Donnel, Kansas City; W. H. Smith, New York; E. D. Martin, Marshall; A. W. Larose, Albany, N. Y.; S. P. Martin, Kansas City, F. M. Catlin, New York; T. F. Marshall, Blackwater, and B. M Reid and W. E. Wright, Kansas City.

NEW PUBLICATIONS.

AMERICAN INSTITUTE OF ARCHITECTS—The American Institute of Architects has issued a bound volume containing a report of the business transacted at the thirty-eighth annual convention, which was held in Washington, D. C., during December and January last. The volume also includes the papers presented, the addresses at the annual dinner, and a list of members.

MOODY'S MAGAZINE—The Moody Corporation, New York city, has issued a prospectus of "Moody's Magazine," a monthly review for investors, bankers and men of affairs, edited by Byron W. Holt. The contents for October, 1905, are suggested as follows: "Critical Comment on Current Events"; symposium—"The Increasing Supply of Gold"; "Unprecedented Prosperity"; "Breakdown of Russian Financial System"; "It Pays to Keep Posted"; "Pitfalls of Speculation"; "Stock Market Outlook"; "Monthly Summary of Leading Financial Events"; "Correspondence"; "Enquiry Department"; "Money, Trade, Commerce and Investments." The subscription price is $3 per year.

TELEPHONE INVESTMENTS, AND OTHERS—Frederick S. Dickson has compiled some interesting data concerning telephone and other investments. This rehearses the question of stocks and bonds as investments, giving considerable statistical data upon the subject. Public service corporations are interestingly handled, and the value of telephone investments is analyzed. The system of the Cuyahoga Telephone Company, Cleveland, Ohio, is carefully described, and there are numerous illustrations of this plant. The probability of telephone development is taken up, and the profits in telephony studied. The book is published by the Cuyahoga Telephone Company, and the price is twenty-five cents; by mail, thirty cents.

"FOR THE RAILROADS"—H. T. Newcomb, Bond Building, Washington, D. C., has published an extensive collection of data concerning the technique of railway management and operation. The preface sets forth the following statement: "This book has been prepared for the railways in order to place before the people of the United States some of the principal facts and arguments which demonstrate the gains that result to all producers and consumers from the free action of commercial forces in shipping and transportation, and the losses that result from unwise statutory restrictions. It is not intended to oppose reasonable and proper legislation for the suppression of rebates, unjust discrimination, or abuses of any kind in railway rates or methods."

OBITUARY NOTICE.

MR. WILLIAM B. RANKINE, vice-president of the Niagara Falls Power Company, died at Franconia, N. H., on September 30. Mr. Rankine's death was caused by congestion of the lungs, superinduced by heart trouble. He went to Franconia to benefit his health on August 12. Mr. Rankine was born at Owego, N. Y., on January 4, 1858. He was also a vice-president of the Niagara Power Company, and was interested in a number of allied concerns.

PERSONAL MENTION.

MR. OWEN M. BURGESS, of Nashville, Tenn., has been appointed superintendent of maintenance with the Kinloch Long-Distance Telephone Company, with headquarters in St. Louis, Mo.

MR. W. J. CONNER, division superintendent of the Pennsylvania Telephone Company, with offices at Johnstown, Pa., has been promoted to a responsible position with the New York division of the Bell Telephone Company.

MR. H. M. WRIGHT, for the past nineteen years manager of the Lynchburg (Va.) office of the Bell Telephone Company, has been appointed to a higher position in the general offices of the company at Atlanta, Ga.

MR. L. H. CUSHING has been appointed superintendent of the Taunton & Pawtucket Street Railway system to succeed Superintendent Richards, who has been transferred to the Taunton, Middleboro & Buzzard's Bay system.

MR. A. E. HUNTLEY, manager of the Muskegon exchange of the Michigan Telephone Company, has been appointed to the management of the Ludington (Mich.) exchange. He will be succeeded at Muskegon by John Wrather.

MR. MORGAN ROYCE and Miss Marjorie Eleanor Keefe were married in Washington, D. C., at the Church of Our Father, Wednesday evening, October 11, at 7.30 o'clock. Mr. and Mrs. Royce will make their home at 1823 Baltimore street, N. W., Washington.

MR. CHARLES L. SEEGER will represent the Electric Storage Battery Company in Mexico, his office being at Primera de Humboldt, No. 10, Mexico City. Mr. W. G. Davis, who has for some time been connected with the Electric Storage Battery Company in its Philadelphia sales office, is now associated with Mr. Seeger in the Mexican office, and his thorough familiarity with storage battery practice will enable him to take up all engineering matters in this special field of electrical work.

MR. FRANK HOOKER ALFRED is now associated with the Canadian White Company, Montreal, Quebec. Mr. Alfred has been actively engaged in railroad construction from the time he finished his education at the University of Michigan and the Ohio State University. For four years he had charge of the field work on the construction of terminals at Columbus, Ohio, for the Norfolk & Western Railroad. For two years he was with the engineering department of the Hocking Valley Railroad. He has also held the post of engineer of maintenance of way for the Cleveland, Akron & Columbus Railway and also the Wheeling & Lake Erie Railroad. In 1900 he was appointed division engineer of the Pere Marquette Railway, and in two years was promoted to the post of chief engineer. During this time the railway was reorganized and extended into Chicago and Buffalo, involving the construction of new line and terminals. New shop buildings and yards at Grand Rapids, Mich., and new shops at St. Thomas, Ontario, have recently been completed under his supervision.

MR. A. T. TOMLINSON has been transferred from the New York office of J. G. White & Company to the Montreal offices of the Canadian White Company. Mr. Tomlinson is a graduate of the Royal Military College of Canada. During the Northwest Rebellion he saw service as a lieutenant in the Midland Battalion. For six years he was engaged in railway work, such as location, construction and the betterment of way, a greater part of his time being spent in Nebraska and Colorado. He also had charge of the double-track work on the Burlington & Missouri Railway out of Omaha. Mr. Tomlinson made a betterment of way survey for the Denver & Rio Grande Railway through a large part of the Grand Cañon of the Arkansas river between Pueblo and Salida. He located and built the Leadville cutoff and branch into Fort Logan. He was assistant engineer of location to Lake City on the Lake fork of the Gunnison, and on the location of the Manitou and Pike's Peak cog road. Mr. Tomlinson has also been connected with the engineering and maintenance of way departments of the Denver & Rio Grande Railway; the Brooklyn Elevated Railway; the Lake Street Elevated, of Chicago; and the Union Loop and Northwestern Road, of Chicago. In 1898 he was called to Boston to assist in the building of the Boston Elevated Railway, as consulting engineer. He had charge of a large part of the construction, and resigned before the completion of the work to enter the employ of the White company in 1902.

ELECTRICAL SECURITIES.

While, as was pointed out in the last review in these columns, the market developed into a period of marking time, awaiting new developments in the monetary situation, there were a few days when a fairly consistent activity was evidenced. At these sessions prices rose to new high levels, and there are indications that the near future will see a decidedly bullish condition of affairs. The high general average of prices, coupled to the fact that the sale of a Stock Exchange membership brought the high price of $85,000, with the suggestion from several quarters that before the end of the year such a privilege would sell for $100,000, indicates that in the minds of at least some large investors the winter market will be a valuable one. It is believed that big speculation will be the order of the day close on to the approach of the holidays. The business failures for the first nine months of the year show liabilities of $76,234,000, against $111,659,000 last year. The freight congestion and car shortages show a favorable condition in this direction. Other recent comparisons also indicate an unabated condition of prosperity, and, above all, the feeling of buoyancy and the absence of any possibility of a far-reaching change in the political situation for some time bid fair for a continuance of this exalted feeling of security.

ELECTRICAL SECURITIES FOR THE WEEK ENDING OCTOBER 7.

New York:	*Closing.*
Brooklyn Rapid Transit	71¼
Consolidated Gas	185⅛
General Electric	179
Interborough Rapid Transit	210
Kings County Electric	200
Manhattan Elevated	165½
Metropolitan Street Railway	126½
New York & New Jersey Telephone	169
Westinghouse Manufacturing Company	187½

The gross earnings of the Brooklyn Rapid Transit Company for September show an increase of $5,200 per day over September of last year. Gross earnings for the September quarter increased $500,000.

The gross earnings of all the lines in the Metropolitan system show for the month of September a continuance of the increase over last year's business, which began to be noted early in the summer and is still in evidence during the current month. The increase for September is well up to the average for July and August, approximating $50,000 for the month.

Boston:	*Closing.*
American Telephone and Telegraph	138½
Edison Electric Illuminating	250
Massachusetts Electric	56½
New England Telephone	136½
Western Telephone and Telegraph preferred	95

Philadelphia:	*Closing.*
Electric Company of America	11⅜
Electric Storage Battery common	83
Electric Storage Battery preferred	83
Philadelphia Electric	9
Philadelphia Rapid Transit	28
United Gas Improvement	92¼

The English subsidiary of the Electric Storage Battery Company has issued its annual report, and the figures show that the year just closed was the best in the history of the plant. Dividends of 6 per cent on the preferred and 8 per cent on the common stock were paid, but earnings were sufficient to pay about 70 per cent on the common, which high rate was, of course, due to small amount of this issue. All of the common stock of the English company is owned by the American company.

Chicago:	*Closing.*
Chicago Telephone	135
Chicago Edison Light	159
Metropolitan Elevated preferred	70
National Carbon common	62½
National Carbon preferred	115½
Union Traction common	13½
Union Traction preferred	37

Northwestern Elevated for September showed daily an average of 74,307 passengers, an increase of 7,900.

The Chicago Telephone Company's monthly statement of instrument output shows a gain of 2,024 telephones installed during September.

INDUSTRIAL ITEMS.

THE MOORE ELECTRICAL COMPANY, Newark, N. J., is distributing two attractive bulletins calling attention to the characteristics of the Moore system of lighting.

THE DEAN ELECTRIC COMPANY, Elyria, Ohio, announces the enlargement of its factory. Its new building, now nearly completed, will give it seventy-five per cent increased capacity.

THE IDEAL STOKER COMPANY, 114 Liberty street, New York city, has secured a contract for the installation of "Ideal" stokers at the Bayonne (N. J.) works of the Para Recovery Company.

THE PITTSBURGH TRANSFORMER COMPANY, Pittsburgh, Pa., is distributing the usual photograph calendar card for October. Attention is also being called to the standard Pittsburgh transformers.

STANLEY & PATTERSON, INCORPORATED, 40 Cortlandt street, New York city, is again calling attention to the "Faraday" skeleton bell. The contact points are made of pure platinum and are riveted in.

FRANK B. COOK, 246 West Lake street, Chicago, Ill., is calling attention to the universal guy clamps, the "U" bolt clips and multiple contact test connectors. These specialties are meeting with great success in the field.

THE WESTINGHOUSE TRACTION BRAKE COMPANY, Pittsburg, Pa., has issued a new bulletin detailing the prices of the parts of the type D, form EG, direct-current, motor-driven air-compressor. This is for size No. 4, gear-driven.

PASS & SEYMOUR, INCORPORATED, Solvay, N. Y., is bringing to the attention of the electrical contractor its double-pole sockets. These double-pole sockets possess features which, the manufacturer claims, are of especial merit. Full information may be secured upon application.

THE SPEAR CARBON COMPANY, St. Marys, Pa., distributed two characteristically artistic souvenirs at the recent Street Railway convention, one of which was a delicately printed little brochure entitled "The Life of Paul Jones," and the other in the form of a paper-weight. This company was represented by Mr. J. S. Spear and Mr. G. P. Fryling.

THE ROCK ISLAND STORAGE BATTERY COMPANY, Cincinnati, Ohio, owing to inadequate facilities for handling its increasing business, announces that on or about October 20 it will remove its entire plant and business to 456-462 East Sixth street. The company will have a plant of over 40,000 square feet of floor space, equipped with the most modern machinery, and will be able to give orders very prompt attention.

THE COPLEY-SENIOR CARBON COMPANY, 465 Greenwich street, New York city, manufacturer of the Copley-Senior carbon brushes for generators and motors, will shortly issue a new catalogue descriptive of its products. This will contain a car-motor sheet, a trip sheet, and a pig-tail brush sheet. The information will be thoroughly up to date in every way, and will embody the newest features of this department of operation.

THE CHICAGO PNEUMATIC TOOL COMPANY, Chicago, Ill., reports a continuance of good business and very bright prospects for the remaining year. The American Car and Foundry Company has recently added to its equipment at the Madison plant, Granite City, for the construction of steel and composite cars, 100 Boyer long-stroke riveting hammers manufactured by the Chicago Pneumatic Tool Company. This order has been secured after a careful test of various makes of riveting hammers.

THE MILLER ANCHOR COMPANY, Norwalk, Ohio, was represented at the Street Railway convention by its president, Mr. George H. Miller. The Guy anchors manufactured by this company are now used by some of the largest electric light, street railway and telephone companies, among which may be mentioned the American Bell Telephone Company, De Forest Wireless Telegraph Company, Lake Shore & Michigan Southern Railway and Chicago-Louisville Traction Company.

THE DAYTON MANUFACTURING COMPANY, Dayton, Ohio, is distributing bulletin No. 131. This bulletin contains, for the most part, the same reading matter as bulletin No. 130. The demand for the latter bulletin was so great that it has been found necessary to get out a second edition. In doing so, the company has added a detailed description of the new "S. B." type cells. The construction of this apparatus is comparatively new, and will be of general interest to any one concerned in electric storage batteries.

THE APPLETON ELECTRIC COMPANY, Chicago, Ill., will be pleased to send its new catalogue, descriptive of its tested fuse wire and strip, fuse links, locknuts, bushings, glass fuses, tubular line fuses, guy clamps, cable hangers, copper test connectors, distributing boards, telephone fuse blocks and fuses. Mr. A. S. Merrill is the eastern representative of the company, at 227 Fulton street, New York city. Mr. Merrill was formerly connected with the Chicago Fuse Wire and Manufacturing Company. The eastern office of the company is carrying a full stock of all the goods listed in the catalogue.

THE MORSE CHAIN COMPANY, Trumansburg, N. Y., has found it necessary to build a large new plant at Ithaca, N. Y., to operate in conjunction with the present factory at Trumansburg. The new buildings will include a foundry, forge shop, pattern shop and power-house. Steel and concrete have been used throughout in the construction of the buildings. A machine-shop equipment has been installed to the amount of $50,000. The machine shop will be equipped with ten-ton electric traveling cranes. The foundry will be equipped with electric cranes of fifteen tons capacity, having a span of fifty feet.

THE WILLIAM ROCHE DRY BATTERY COMPANY, New York city, has been incorporated and now owns the business which has been conducted since the year 1897 by William Roche at No. 52 and 54 Park Place. The company is organized under the laws of the state of New York, with a fully paid capital of $25,000. Mr. William Roche is president of the new corporation, and has associated with him C. Layton Ford, formerly first vice-president of the Celadon Roof Tiling Company, New York city; Ernest A. Lowe, president of the Lowe Electric Company; and William C. Hubbard, for a number of years with the Westinghouse Electric and Manufacturing Company. The assets of the business have been taken over by the new corporation, and all of its liabilities have been assumed and will be paid by the new company.

THE INTERNATIONAL ACHESON GRAPHITE COMPANY, Niagara Falls, N. Y., has recently completed a large extension equipped with modern electrical and mechanical appliances. This extension has doubled the capacity of its plant for creating graphite in the electric furnace. The company has closed a contract with the Niagara Falls Power Company for 1,000 horse-power in addition to the 1,000 heretofore used. The commercial importance of artificial graphite may be estimated from the fact that the United States geological report for 1904 states that for that year the value of Acheson graphite produced was $217,790, while all the graphite mined in this country amounted merely to $341,372. Acheson graphite is largely used in the manufacture of metal protective paints, dry batteries, stove polish, packing and lubricants. The electrochemical processes also consume an extensive supply of Acheson graphite electrodes.

THE BROWN HOISTING MACHINERY COMPANY, Hamilton and Belvin streets, Cleveland, Ohio, has issued its new "Brownhoist" catalogue. This catalogue describes and illustrates a line of machines of the Brown type for unloading coal or iron ore from boats and delivering it either into railroad cars or stock piles, or *vice versa*. Apparatus is also described for the hoisting and conveying of general merchandise at docks, steel works and blast furnaces, and for the handling of material during the construction of ships at shipyards. Other features of the book are descriptions and illustrations of the furnace hoists and stock distributor for the charging of blast furnaces. There are, besides this, described many other plants for the handling of material in the yards of steel works, structural shops, etc. The "Brownhoist" suspended pocket is illustrated, this construction being used in connection with the charging larries in many of the largest steel works. This enumeration, however, is but a very brief index of the great variety of information and instruction contained in this volume. The book is handsomely printed, the illustrations being very carefully worked out. In addition to the fine press-work and typography the book is substantially bound, and bears a gold illumination on the green baize cover.